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INM
Integrated Noise Model
Version 4.11

User's Guide - Supplement

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13. ABSTRACT (Maximum 200 words)
The John A. Volpe National Transportation Systems Center (Volpe Center), in support of the Federal Aviation administration, Office of Environment and Energy, has developed Version 4.11 of the Integrated Noise Model (INM). The User's Guide for the Version 4.11 computer software is a supplement to INM, Version 3, User's Guide - Revision 1 for the Version 3.10 computer software released in June, 1992. The Version 4.11 supplement, prepared by the Volpe Center's Acoustics Facility, presents computer system requirements as well as installation procedures and enhancements. Specific enhancements discussed include: (1) the introduction of a takeoff profile generator; (2) the ability to account for terrain elevation around a specified airport; (3) the ability to compute the CNEL, WECPNL, LEQDAY, and LEQNIGHT noise metrics; (4) the ability to account for airplane runup operations; (5) the ability to account for displaced runway thresholds during approach operations; (6) an enhancement to the noise contour computations: (7) an increase in the number of takeoff profile segments; and (8) enhancements to the echo file.

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PREFACE

This document was prepared by the John A. Volpe National Transportation Systems Center (Volpe Center), in support of the Federal Aviation Administration, Office of Environment and Energy. It is a User's Guide for the Integrated Noise Model (INM) Version 4.11 computer software used to predict noise impact around airports. This User's Guide is a supplement to INM, Version 3, User's Guide - Revision 1, which was released in June, 1992, along with the INM Version 3.10 computer software. The Version 4.11 supplement, prepared by the Volpe Center's Acoustics Facility, presents computer system requirements as well as installation procedures and INM Version 4.11 enhancements.

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	l
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 l shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	l
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
psi	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.195	square yards	ac
ha	hectares	2.47	acres	mi^2
km^2	kilometers squared	0.386	square miles	
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
l	liters	0.264	gallons	gal
m^3	meters cubed	35.71	cubic feet	ft^3
m^3	meters cubed	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg	megagrams	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	psi

* SI is the symbol for the International System of Units

(Revised January 1992)

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1. INTRODUCTION

During June, 1992, through December, 1993, the John A. Volpe National Transportation Systems Center (Volpe Center), in support of the Federal Aviation Administration, Office of Environment and Energy, developed Version 4.11 of the Integrated Noise Model (INM). The User's Guide for the Version 4.11 computer software, prepared by the Volpe Center's Acoustics Facility, is a supplement to the Integrated Noise Model (INM), Version 3, User's Guide - Revision 1[1] for the Version 3.10 computer software released in June, 1992. Section 1.0 of the supplementary document presents computer system requirements and installation procedures for INM Version 4.11. Section 2.0 describes the user's implementation of several new capabilities, including descriptive examples. Appendix A describes the technical revisions made to several internal algorithms - primarily revisions which are transparent to INM users. Appendices B and C, respectively, present a technical discussion of two new capabilities, the takeoff profile generator and the capability to account for airplane runup operations. Appendix D presents a copy of the INM Input Testcase, revised to reflect INM Version 4.11 enhancements. Appendix E contains a copy of the User's Manual for the WINM computer software, an INM Version 4.11 plotting program for use with Microsoft Windows.

1.1 Computer System Requirements

INM Version 4.11 operates on an IBM Personal Computer (PC)-Compatible platform with the following minimum configuration:

- IBM PC-AT or compatible, Series 286 microprocessor;
- 3 MB of available hard disk space;
- 590 KB of Random Access Memory (RAM) or 3 MB of RAM, if operating the INM from a RAM disk, as discussed in Section 1.2.1 below;
- Math co-processor, Series 80287; and
- Microsoft-compatible Disk Operating System (MSDOS) Version 3.3.

In addition, the CONFIG.SYS file on the PC slated for INM Version 4.11 installation must contain the following lines: BUFFERS=30; and FILES=30.

1.2 Installation

The files on the INM Version 4.11 system diskette have been stored in a compressed format using the PKZIP Version 1.1 utility software [Copyright (c) 1990 PKWare, Inc.]. With the source drive prompt displayed on the screen, execute the UNPACK batch file to install INM Version 4.11 on your PC:

- **UNPACK <SOURCE DRIVE> <TARGET DRIVE>**

For example, the command UNPACK A C will install, from the A drive, INM Version 4.11 on the C drive in a subdirectory called INM411. Note: The UNPACK batch file will, without prompting, overwrite the contents of subdirectory INM411, if one exists on the user-specified target drive.

1.2.1 RAM Disk Installation

Operation of INM Version 4.11 on a RAM disk will improve computation time by an estimated 5 to 15 percent, as compared to operating it from a hard-disk drive. RAMDRIVE.SYS, an installable device driver supplied with Microsoft-compatible DOS, allows a user to configure part of the PC's RAM as if it were a hard disk (i.e., a RAM disk, sometimes referred to as a virtual disk). The following is an example installation of INM Version 4.11 onto a RAM disk. The user is referred to the DOS manual and/or the manual supplied with any memory management software being used if difficulties should occur.

To install RAMDRIVE.SYS for use with INM Version 4.11, the following command line should be included in the CONFIG.SYS file:

- **DEVICE=C:\DOS\RAMDRIVE.SYS 3000/E**

Upon including the above command line in the CONFIG.SYS file, the PC must be rebooted. After rebooting, the PC will have a 3 MB RAM drive located in extended memory. The RAM drive's logical, alphabetical drive designation will be one letter higher than the highest current physical drive on the PC (e.g., if a PC has a 5¼ inch A-drive, a 3½ inch B-drive, and a hard-disk C-drive, upon rebooting, the RAM drive will be designated the D-drive). The user may now install the INM software on the RAM drive by designating it as the target drive for installation. For example:

- **A:\UNPACK A D**

The above command will automatically install the INM from the A-drive onto a subdirectory (INM411) on the RAM drive (i.e., in this example the D-drive). The RAM drive must now be logically connected to the hard drive using DOS's JOIN command. To accomplish this, an empty subdirectory, e.g., C:\RAM, must be created on the hard drive. From within that subdirectory execute the following command:

- **C:\RAM\JOIN D: C:**

This will assign the RAM drive, i.e., the D-drive, to operate within the subdirectory C:\RAM on the hard drive. Note: It is extremely important to remember that each time the PC is reset or its power is turned off, the information stored on the RAM drive will be lost. As a result, if the INM is run from the RAM drive, all files must be copied to a physical drive, e.g., a floppy drive, prior to powering-off the PC.

2. IMPLEMENTATION OF INM VERSION 4.11 ENHANCEMENTS

This Section of the document describes the methodology for implementing INM Version 4.11 enhancements. It includes a background discussion of the enhancements, a brief discussion of the need for the enhancements, and example implementation of the enhancements. The following enhancements are discussed: (1) the takeoff profile generator; (2) the ability to account for terrain elevation around a specified airport; (3) the ability to compute the CNEL, WECPNL, LEQDAY, and LEQNIGHT noise metrics; (4) the ability to account for airplane runup operations; (5) the ability to account for runway thresholds during approach operations; (6) an enhancement to the noise contour computations; (7) an increase in the number of takeoff profile segments; and (8) enhancements to the echo file.

2.1 Takeoff Profile Generator

This enhancement allows for the computation of airplane takeoff profiles based on the user-supplied airport elevation and temperature entry in the SETUP section of the INM input file. The takeoff profiles are utilized by the INM in the computation of all noise metrics. Previous versions of the INM utilize takeoff profiles which were based on standard-day conditions, i.e., temperature of 59°F and airport elevation of zero ft Above Mean Sea Level (MSL). Previously, the user-supplied airport elevation (altitude) and temperature were only used to compute an atmospheric acoustic impedance correction.

The takeoff profile generator is made possible by the inclusion of standardized airplane operating procedures and performance coefficients in Data Base Number 11. These procedures and coefficients are presented in References 2, 3, and 4, and accessible from the Data Base using the ACDB11.EXE computer program, supplied with the Version 4.11 release. With the exception of INM airplane numbers 1, 6, 7, 8, 10, 24, 56, 100, 101, and four of the new airplanes (INM airplane numbers 104 to 107) discussed further in Appendix A, the operating procedures and performance coefficients required for takeoff profile computation are included in Data Base Number 11. For the airplanes without standard procedures and coefficients the takeoff profile for standard conditions is assumed regardless of the airport elevation and temperature. Note: The incorporation of the takeoff profile generator will not affect the standard approach profiles. The approach profiles are the same as employed in INM Version 3.10.

Operation of the profile generator is time-efficient and entirely transparent to the user. If other than standard-day conditions are specified by the user in the SETUP portion of the input file, the profile generator automatically computes the takeoff profiles using the airplane performance coefficients in Data Base Number 11 and the equations in the

Society of Automotive Engineers Aerospace Information Report 1845[5] (SAE/AIR 1845). When an airport elevation and temperature is not specified, the INM assumes standard conditions and utilizes the standard profiles included with Data Base Number 11, i.e., the internal profile generator will not be exercised.

To insure the takeoff profiles and resultant noise metrics computed by INM Version 4.11 are reasonable for the user-defined input case, a runway length check has been instituted. When the computed ground roll segment of the takeoff profile exceeds the user-specified runway length, the user is notified of the discrepancy. A message similar to the following is included in the echo file.

- **WARNING: COMPUTED GROUND ROLL ERROR FOR INM AIRPLANE 747200, STAGE WEIGHT 7, -- EXCEEDS USER-DEFINED RUNWAY LENGTH BY X PERCENT FOR THE TAKEOFF ON TRACK TR1,RUNWAY 09L.**

In many cases this warning will indicate to the user that there is an error in the input file, possibly in the user-defined average yearly temperature, airport elevation, airport runway length, or airplane stage weight. In cases where the computed ground roll segment exceeds the runway length by more than 10 percent, the above message will be included in the echo file as a fatal error rather than a warning and the user will not be permitted to continue processing of the input case.

There may be instances where the user has correctly defined the input case and the computed ground roll segment exceeds the runway length by more than 10 percent. This apparent anomaly may be the result of using the average yearly temperature at the airport as an input. For example, a particular airport may be capable of operating a high stage-weight B747 airplane in the early evening or during winter months only, when the temperature is significantly lower than the average yearly temperature. In such cases it is suggested that a user-defined profile be included in the input file.

In addition, there may be instances (e.g., high stage weights, high temperatures, and high airport elevations combined) where a negative rate-of-climb is computed. Consequently, a fatal error will occur and a profile will not be generated. In such instances, the user will be notified with a message similar to that below; it is suggested that a user-defined profile be included in the input file.

- **FATAL: PROFILE FOR INM AIRPLANE 747200, STAGE WEIGHT 7 CANNOT BE COMPUTED.**

A technical discussion of the takeoff profile generator is presented in Appendix B. In addition, Appendix B presents tables which summarize the runway requirements and operational boundaries of the profile generator. These tables are presented for various combinations of airport elevation and temperature intended to cover the range of average yearly conditions at airports across the United States.

2.2 Terrain Elevation

This user-selectable enhancement included with INM Version 4.11 allows for the computation of source-to-receiver slant range, i.e., propagation distance, based upon actual terrain elevation at receiver locations around a specified airport. The implementation of this enhancement can result in a vast improvement in the accuracy of the noise computations at airports located near hilly terrain, however its implementation will result in an increase in computation time by an estimated 50 to 100 percent. To utilize this enhancement, INM Version 4.11 users must have the United States Geological Survey (USGS) 3 Arc Second Elevation Data on CD-ROM, available from:

Rocky Mountain Communications, Inc. (RMC)
2023 Montane Drive East
Golden, CO 80401
(303) 526-5454
(303) 526-2662 (FAX)

The USGS data are available for the entire United States or parts thereof.

Prior to implementing the elevation enhancement within INM Version 4.11, the preprocessing program, MAKEFILE.EXE, which is included with the Version 4.11 distribution package, must be run on the RMC Digital Elevation Model (DEM) files. MAKEFILE.EXE constructs a 2.8 MB, one-degree by one-degree, geodetic data file with the user-specified airport located at the geographic center of the file. The file generated by MAKEFILE.EXE, which has a three-letter user-defined prefix and a .3CD extension (e.g., Boston's Logan International Airport might be designated BOS.3CD), will be used by INM Version 4.11 to compute the source-to-receiver slant range. Use of the MAKEFILE.EXE program is described below.

With the drive prompt displayed on the screen, type MAKEFILE to invoke the program.

- **C:\INM411\ <u>MAKEFILE</u>**

MAKEFILE.EXE will then prompt the user to enter a three-letter airport identification, e.g., BOS, and the latitude and longitude of a reference point at the airport (e.g., the beginning of the primary runway). In the following example the latitude and longitude are for the start of Runway 09L at Boston-Logan.

- **ENTER 3 LETTER AIRPORT IDENTIFIER (EX. BOS): BOS**
- **ENTER RUNWAY LAT COORD. DEGS MINS SECS (EX. 42 21 20): 42 21 20**
- **ENTER RUNWAY LON COORD. DEGS MINS SECS (EX. 71 00 48): 71 00 48**

The MAKEFILE.EXE program then computes the coordinates of the southeast corner of a one-degree by one-degree data-block based upon the start of the airport's primary runway being at the geographic center of the block. The computed southeast corner is displayed along with the four RMC DEM files required to construct the one-degree by one-degree data-block around the airport. The user is also given the option to overwrite an existing or create a new BOS.3CD file, where BOS is the three-letter airport identifier.

- **THE SE CORNER OF THE REQUIRED (1X1 DEG) DATA BLOCK IS: 41 52 70 31**
- **THE REQUIRED DEM FILES ARE: NW FN=42071.3CD NE FN=42070.3CD**
  SW FN=41071.3CD SE FN=41070.3CD
- **DO YOU WISH TO CREATE A NEW BOS.3CD FILE (Y/N) ? Y**

The user should type Y to overwrite/create a new file. If the four DEM files exist in the current directory, the program will create the BOS.3CD file without further prompting. If MAKEFILE.EXE cannot find the required DEM files, it will request that the user enter the drive where the DEM files are resident. In addition, MAKEFILE.EXE will ask if the data are on the RMC CD-ROM and, if so, copy them into the current directory. If the four DEM files are not on the CD-ROM drive, MAKEFILE.EXE will request the path where the files can be found. The program will then construct the required one-degree by one-degree data-file, with the airport's primary runway at its approximate geographic center. The user will be informed that the file has been constructed, and the minimum and maximum elevation within the constructed one-degree by one-degree block will be provided.

- **WRITING OF BOS.3CD IS COMPLETE**

The example BOS.3CD file is now ready for implementation by the INM. To utilize the elevation data in the BOS.3CD file in the computation of source-to-receiver slant range, the user must specify, in the SETUP portion of the INM input file: (1)

the three-letter airport code which identifies the specific user pre-processed .3CD file; (2) the disk-drive location of the .3CD file (Note: It is not necessary to specify the location of the .3CD file if it is in the current directory; also, if the .3CD file resides in a subdirectory, the path to that subdirectory must be created prior to running INM.); and (3) the latitude and longitude of a user-defined reference point at the airport, where the X and Y coordinates of all defined runways must be referenced to this point. To insure that the user has identified the appropriate .3CD file, the INPUT.EXE program will test the user-defined reference point at the airport against the stored reference in the .3CD file.

In the following example the user has: (1) specified Boston's Logan International Airport; (2) identified the C-drive as the location for the BOS.3CD file; and (3) specified the latitude and longitude of a reference point at Boston-Logan.

- **SETUP:**

  TITLE <EXAMPLE IMPLEMENTATION OF ELEVATION ENHANCEMENT>
  AIRPORT <ELEVATION EXAMPLE>

  CODE BOS
  DRIVE C
  LATITUDE 42 21 20
  LONGITUDE 71 00 48

With the elevation enhancement invoked as described above, all noise-level computations are performed based upon the actual source-to-receiver slant range, rather than assuming a flat terrain as was the case in previous versions of the INM.

In addition, the data in the BOS.3CD file are used to compute the slope of a three-by-three arc-second tangential ground plane, with the receiver at its physical center. This ground plane is used in the computation of the source-to-receiver elevation-angle, beta, required by the lateral attenuation algorithm in the INM. The beta angle is defined as the angle subtended by the propagation path from the airplane to the receiver and the three-by-three arc-second ground plane. Figures 2-1 and 2-2, respectively, depict the beta angle for two scenarios: (1) previous versions of the INM (i.e., flat terrain); and (2) INM Version 4.11.

2.3 CNEL, WECPNL, LEQDAY, and LEQNIGHT Noise Metrics

The capability to compute four additional noise metrics has been included in INM Version 4.11. They are the Community Noise Equivalent Level (CNEL), Weighted Equivalent Continuous Perceived Noise Level (WECPNL), Equivalent Sound Level During Daytime Hours (LEQDAY), and Equivalent Sound Level During Nighttime Hours (LEQNIGHT). The addition of these four metrics brings the total number of metrics available for computation by the INM to eight (NEF, LEQ, LDN, TA, CNEL, WECPNL, LEQDAY, and LEQNIGHT). As was the case in previous

Scenario 1

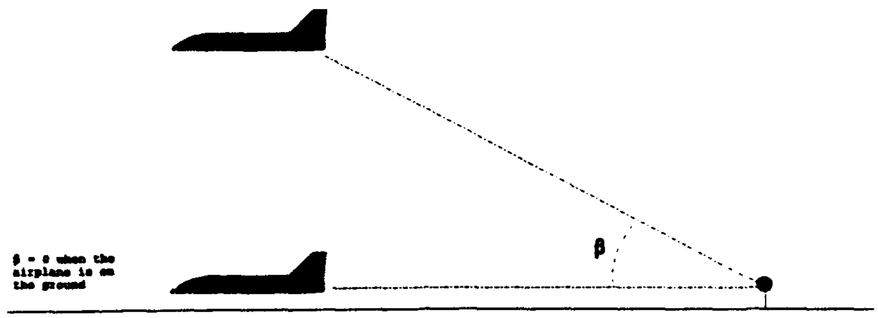

FIGURE 2-1: BETA ANGLE FOR INM VERSION 3.10 AND BEFORE

Scenario 2

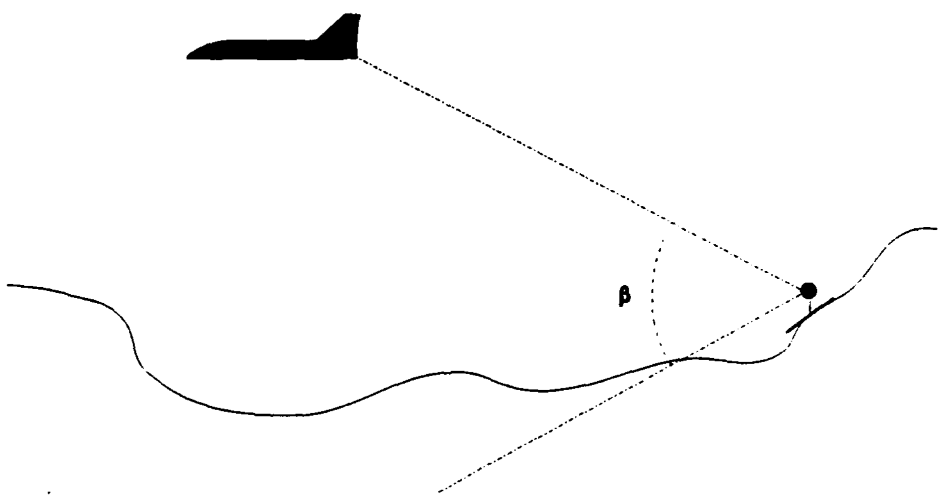

FIGURE 2-2: BETA ANGLE FOR INM VERSION 4.11

versions of the INM, Version 4.11 allows for the computation of all metrics simultaneously in grid mode or a single user-defined metric in contour mode for a given input case. A brief description of the CNEL, WECPNL, LEQDAY, and LEQNIGHT noise metrics follows:

(1) Community Noise Equivalent Level (CNEL): The CNEL noise metric, which is primarily used in California, is similar to the Day-Night Sound Level (LDN) metric in that it incorporates the energy-averaged A-weighted sound level integrated over a 24-hour period. However, unlike LDN, CNEL incorporates an additional penalty for operations occurring between the evening hours of 1900 and 2200 hours. For CNEL, a 3 dB penalty is applied to operations occurring between 1900 and 2200 hours, and a 10 dB penalty is applied to operations occurring between 2200 and 0700 hours. The equation for computing CNEL within the INM is as follows:

$$CNEL = SEL + 10\log_{10}(N_{day} + 3N_{eve} + 10N_{night}) - 49.4,$$

where SEL = Sound Exposure Level in dBA;

N_{day} = number of operations between 0700 and 1900 hours local time;

N_{eve} = number of operations between 1900 and 2200 hours local time;

N_{night} = number of operations between 2200 and 0700 hours local time;

and 49.4 = constant which normalizes CNEL to a 24-hour period, (i.e., $10\log_{10}(1/86{,}400 \text{ sec/day}) = -49.4$).

(2) Weighted Equivalent Continuous Perceived Noise Level (WECPNL): The WECPNL noise metric, which is primarily used by the European Community, is based upon the PNLT noise metric and is computed within the INM as follows:

$$WECPNL = EPNL + 10\log_{10}(N_{day} + 3N_{eve} + 10N_{night}) - 39.4,$$

where all definitions are the same as in CNEL, above, except:

EPNL = Effective Perceived Noise Level in dB; and

39.4 = (49.4 - 10); where 49.4 is the constant which normalizes WECPNL to a 24-hour period, (i.e., $10\log_{10}(1/86,400$ secs/day$) = -49.4$); and -10 is the duration normalizing factor in the definition of EPNL.[6]

(3) Equivalent Sound Level During Daytime Hours (LEQDAY): The LEQDAY noise metric is an energy summation of the aggregate environment, as measured in A-weighted decibel units (dBA) normalized to the 15-hour time period from 0700 to 2200. The equation for computing LEQDAY within the INM is as follows:

$$LEQDAY = SEL + 10\log_{10}(N_{day} + N_{eve}) - 47.3,$$

where all definitions are the same as in CNEL, above, except:

47.3 = constant which normalizes LEQDAY to the 15-hour period from 0700 to 2200, (i.e., $10\log_{10}(1/54,000$ sec$) = -47.3$).

(4) Equivalent Sound Level During Nighttime Hours (LEQNIGHT): The LEQNIGHT noise metric is an energy summation of the aggregate environment, as measured in A-weighted decibel units (dBA) normalized to the 9-hour time period from 2200 to 0700. The equation for computing LEQNIGHT within the INM is as follows:

$$LEQNIGHT = SEL + 10\log_{10}(N_{night}) - 45.1,$$

where all definitions are the same as in CNEL, above, except:

45.1 = constant which normalizes LEQNIGHT to the 9-hour period from 2200 to 0700, (i.e., $10\log_{10}(1/32,400$ sec$) = -45.1$).

2.4 Airplane Runup Operations

This enhancement allows INM Version 4.11 to compute noise levels due to airplane engine runup operations. The need for this particular enhancement is recognized primarily around airplane maintenance facilities. To invoke this capability the user must define an airplane runup in the TAKEOFF section of the input file as follows:

- **INT.NM.**
  TAKEOFFS BY FREQUENCY:

```
TRACK RU1 RWY 09L STRAIGHT 50
     OPERATION 747200 RUNUP 1 D=30
     OPERATION 747200 STAGE 4 D=80
                <OR>
     OPERATION 747200 STAGE 4 D=80 RUNUP 1 D=30
```

In the above example, a 30 second (D=30) runup operation is defined for a B747-200 airplane operation at the thrust setting of Stage Weight 1. The runup, as specified, takes place on a runway designated as 09L and a track designated as RU1. STRAIGHT 50 defines the length of the track in nautical miles. In fact, the track length for runup operations is ignored in the computation of runup noise. For runup noise computations it is assumed that the airplane covers a track with an arbitrarily chosen fixed length of 20 ft. The specific location and heading of the runup operation in the above example must be defined in the RUNWAYS section of the input file as shown in the following:

```
•    RUNWAYS
           RW 09L-27R   0    0 TO 9487    -497
```

In the above example, the runup operation takes place at the start of an active runway, i.e., Runway 09L. If the user wants to define a runup operation at a location at the airport other than on an active runway, e.g., at a maintenance facility, then the maintenance facility must be defined as if it were a runway. Here it is suggested that a maintenance facility, or any other location specified for a runup operation, be defined as a runway which is 20 ft in length. The definition of a maintenance facility as a 20 ft runway is shown in the following example.

```
•    RUNWAYS
           RW 13-31   0   5000 TO 20   5000
```

The above runup definitions assume that the full-power takeoff thrust associated with the user-defined stage weight is maintained for the duration of the runup. However, runup operations can occur at other than full-power thrust. To model such instances, a user-defined runup should be included in the input file as follows:

```
•    AIRCRAFT:
       TYPES
         AC 747200 STAGE 1=RU

     PROFILES TAKEOFF
       PF RU SEGMENTS=3 WEIGHT=525000 ENGINES=4
         DISTANCES       0      10     20
         ALTITUDES       0      0      0
         SPEEDS          160    160    160
         THRUSTS         35022  35022

     INT.NM.
     TAKEOFFS BY FREQUENCY:

     TRACK RU1 RWY 09L STRAIGHT 50
           OPERATION 747200 RUNUP 1 D=30
```

In addition, the specific location, e.g., the start of a runway or at a maintenance facility, and heading of the runup operation in the above user-defined example must be specified in the RUNWAYS section of the input file as discussed earlier in this section. A technical discussion of the airplane engine runup capability is presented in Appendix C.

2.5 Approach Runway Thresholds

The capability to account for displaced runway thresholds for approach operations has been added to INM Version 4.11. In previous versions of the INM, the runway touch-down point was assumed to be a fixed 954 ft from the edge of the runway for airplanes with a three degree approach glide slope, and 572 ft for the four airplanes with a five degree approach glide slope (INM airplane numbers 74 to 77). With INM Version 4.11, a user-defined displaced threshold (DT), either positive or negative, is added to the fixed runway touch-down point. To insure realistic DT's are defined by the user, they are checked versus the runway coordinates. If discrepancies exist, the user is notified in the echo file, as appropriate. In the following example, a 1454 ft runway touch-down point has been defined in the SETUP section of the input file for Runway 09L (i.e., 500 ft for the user-defined DT plus 954 ft for the fixed touch-down point); and a runway touch-down point of 954 ft has been defined for Runway 27R:

- **SETUP:**

```
TITLE <EXAMPLE IMPLEMENTATION OF APPROACH RUNWAY THRESHOLD>
AIRPORT <RUNWAY THRESHOLD EXAMPLE>

ALTITUDE 23
TEMPERATURE 12.66 C

RUNWAYS
      RW 09L-27R   0 0 DT 500 TO 9487 -497 DT 0
                              <OR>
      RW 09L-27R   0 0 DT 500 TO 9487 -497
```

The above runway definition is depicted graphically below:

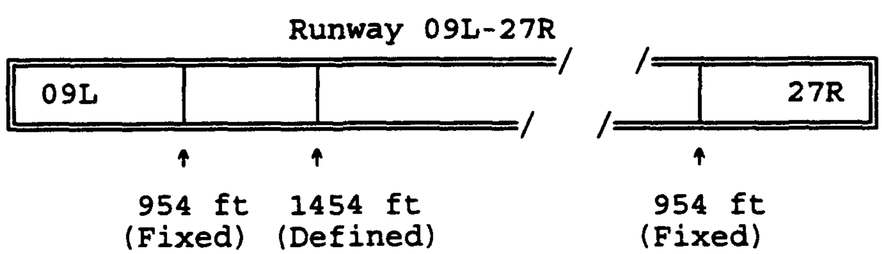

FIGURE 2-3: RUNWAY DEFINITION

The inclusion of the 500 ft user-defined DT results in a runway touchdown point 1454 ft from the start of Runway 09L (i.e., 500 ft for the user-defined DT plus 954 ft for the fixed touch-down point).

2.6 Noise Contour Computations

INM Version 4.11 provides, in the echo file, a warning to users when there are insufficient grid points to accurately compute a specific noise contour. In previous versions, the INM would automatically make the determination that there were insufficient grid points, and return a run-time error to the computer display without further explanation. The INM's noise computation window must be redefined to encompass additional grid points in the area of interest.

If the user-defined computational window is too coarse to allow computation of a requested contour or the requested contour is not encompassed by the window, INM Version 4.11 will include a message in the echo file which is similar to the following:

```
•    CONTOUR        CONTOUR AREA
      LEVEL         (SQ. MILES)
     -------        ------------

     CN 3 *WARNING:  LDN 30.0 CONTOUR DOES NOT EXIST
```

In the above example, the defined window was either too coarse to reliably compute the user-requested 30 dB LDN contour or the contour was not encompassed by the window.

2.7 Takeoff Profile Segments

INM Version 4.11 provides for user-defined takeoff profiles with up to 18 segments. Previous versions of the INM limited the number of segments to 14. This enhancement allows for more precise user-defined takeoff profiles. It will also more easily facilitate the incorporation of a flight-procedure generator planned for a future version of the INM, since certain procedures may require higher resolution profiles, and thus more segments.

2.8 Echo File

All output reports generated by INM Version 4.11 have been modified to account for the enhanced capabilities discussed in Section 2.0, above.

3. REFERENCES

[1] Flythe, M.C., Integrated Noise Model Version 3, User's Guide - Revision 1, Report No. DOT/FAA/EE-92/02, Arlington, VA: CACI, Inc. - Federal, June 1992.

[2] Bishop, D.E., Mills, J.F., Update of Aircraft Profile Data for the Integrated Noise Model Computer Program, Volume 1, Report No. FAA-EE-91-02, Canoga Park, CA: Acoustical Analysis Associates, Inc., March 1992.

[3] Bishop, D.E., Mills, J.F., Update of Aircraft Profile Data for the Integrated Noise Model Computer Program, Volume 2, Report No. FAA-EE-91-02, Canoga Park, CA: Acoustical Analysis Associates, Inc., March 1992.

[4] Bishop, D.E., Mills, J.F., Update of Aircraft Profile Data for the Integrated Noise Model Computer Program, Volume 3, Report No. FAA-EE-91-02, Canoga Park, CA: Acoustical Analysis Associates, Inc., March 1992.

[5] Procedure for the Calculation of Airplane Noise in the Vicinity of Airports, SAE/AIR 1845, Warrendale, PA: Society of Automotive Engineers Committee A-21, Aircraft Noise, 1986.

[6] Federal Aviation Regulations, Part 36, Noise Standards: Aircraft Type and Airworthiness Certification, Washington, D.C.: Federal Aviation Administration, December 1988.

APPENDIX A

REVISIONS TO INM ALGORITHMS

This Appendix discusses, in general terms, revisions to several algorithms and subroutines included in INM Version 4.11. It also discusses the rationale for these revisions and presents their effects on the noise contours, where applicable. The associated computer source code is not included. All revisions discussed below are transparent to the user in that they do not affect user-operation of the INM. However, these revisions will result in more accurate INM noise predictions and an increase in INM computational efficiency. They include: (1) revisions to the flight significance testing within the INM; (2) implementation of a directivity smoothing equation; (3) revisions to the dipole directivity pattern within the INM; and (4) revisions to the INM Data Base.

A.1 Flight Significance Testing

The methodology employed for determining flight noise significance during grid computations has been streamlined in INM Version 4.11. Rather than looping through each of the first four refinement levels individually and constructing the noise grid on a level-by-level basis, INM Version 4.11 begins by constructing the 17-by-17 point regular grid previously associated with the fourth refinement level, and setting all parameters associated with the 289 total points, including the noise significance flags for each point.

In restructuring the flight significance methodology, it was discovered that INM Version 3.10 was performing unnecessary (i.e., insignificant) noise computations due to improper setting of the flight significance flags. This impropriety had no effect on the computed noise levels but it did increase run-time unnecessarily. Revising the methodology for grid development, including the proper setting of flight significance flags, improved computation time by an estimated 40 percent over INM Version 3.10, for comparable input cases.

A.2 Directivity Smoothing Equation

The directivity algorithm of SAE/AIR 1845 implemented for receivers behind start-of-takeoff roll, which is based on field-measured data published in 1980, has been maintained within INM Version 4.11. However, a directivity smoothing equation, operating as a function of distance, has been implemented. In previous versions of the INM, the directivity algorithm is applied to noise levels behind start-of-takeoff-roll regardless of lateral distance. In the 1980 study, measurements were made at distances from start-of-takeoff-roll of only 970 to 1280 ft. Recent studies[6,7] have indicated that INM Version 3.10 tends to underpredict noise levels behind start-of-takeoff-roll at distances of 3000 to 5000 ft, well beyond those represented in the 1980 study. This underprediction was especially evident for measurements made directly behind the airplane where the reduction in noise level due to the directivity algorithm is most pronounced.

As a result, an equation has been incorporated into INM Version 4.11 which smooths out the directivity effect as a function of distance behind the airplane, beginning at a distance of 2500 ft. The smoothing algorithm reduces the directivity effect in decibels by a factor of 50 percent per doubling of distance behind the airplane, beginning at a distance of 2500 ft. For example, a noise level attenuation of 10 dB computed by the directivity algorithm at a distance of 2500 ft will be reduced to 5 dB at 5000 ft due to the smoothing equation.

The smoothing equation built into INM Version 4.11 was empirically and conservatively derived from the data of Reference 6, the more detailed study of the two cited above. However, it is strongly recommended that additional measurments behind start-of-takeoff-roll be performed at a variety of offset distances and azimuth angles at several sites across the country to fine-tune the smoothing equation.

A.3 Dipole Directivity Pattern

The 90° dipole directivity pattern was originally instituted within the INM as a means of approximating the directivity characteristics of an airplane in flight. Although the exact directivity characteristics are a function of parameters such as airplane type, power setting, speed, and distance, the dipole model has served as a reasonable approximation. In INM Version 4.11, the 90° dipole directivity pattern has been modified. Figures A-1 and A-2 depict the dipole directivity pattern of INM Version 3.10 and earlier versions, and the modified pattern of INM Version 4.11, respectively. For INM Version 4.11, the original dipole directivity directly in front of and behind the airplane has been suppressed. In addition, the directivity algorithm of SAE/AIR 1845, with the addition of the smoothing equation discussed in Section A.2 above, is applied behind the airplane for <u>all</u> modes of operation. See Appendix C for a discussion of the appropriateness of the modified directivity pattern for runup operations.

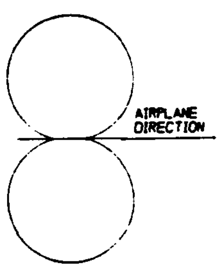

FIGURE A-1: DIPOLE DIRECTIVITY PATTERN, INM VERSION 3.10 AND BEFORE

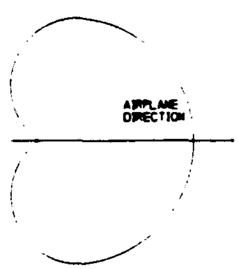

FIGURE A-2: MODIFIED DIRECTIVITY PATTERN, INM VERSION 4.11

The effect of the modified directivity pattern on the noise contours is depicted in Figures A-3 and A-4, below. Figure A-3 shows the effect on the SEL footprint for a single takeoff operation of the B737-200 airplane (INM number 47). Figure A-4 shows the effect on the LDN contour for the INM Input Testcase provided with INM Version 3.10.

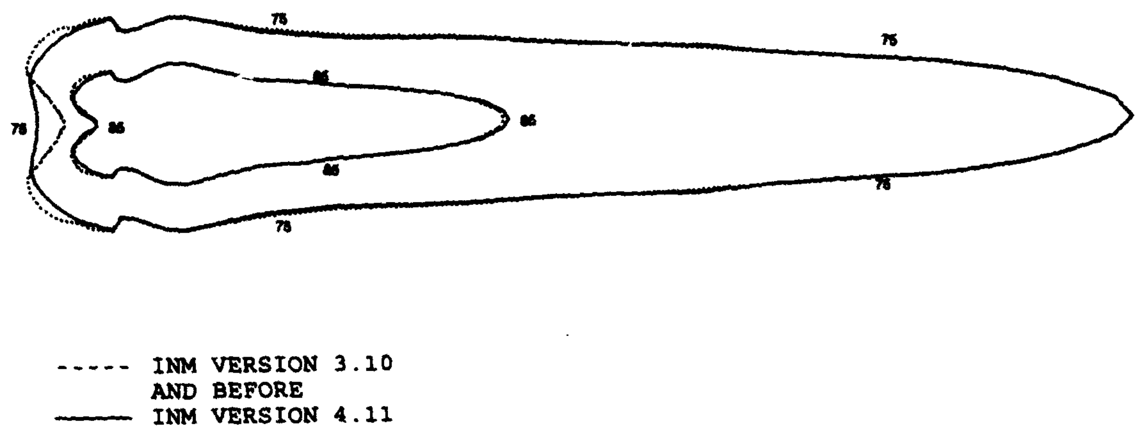

FIGURE A-3: SEL TAKEOFF FOOTPRINT COMPARISON FOR B737-200 AIRPLANE

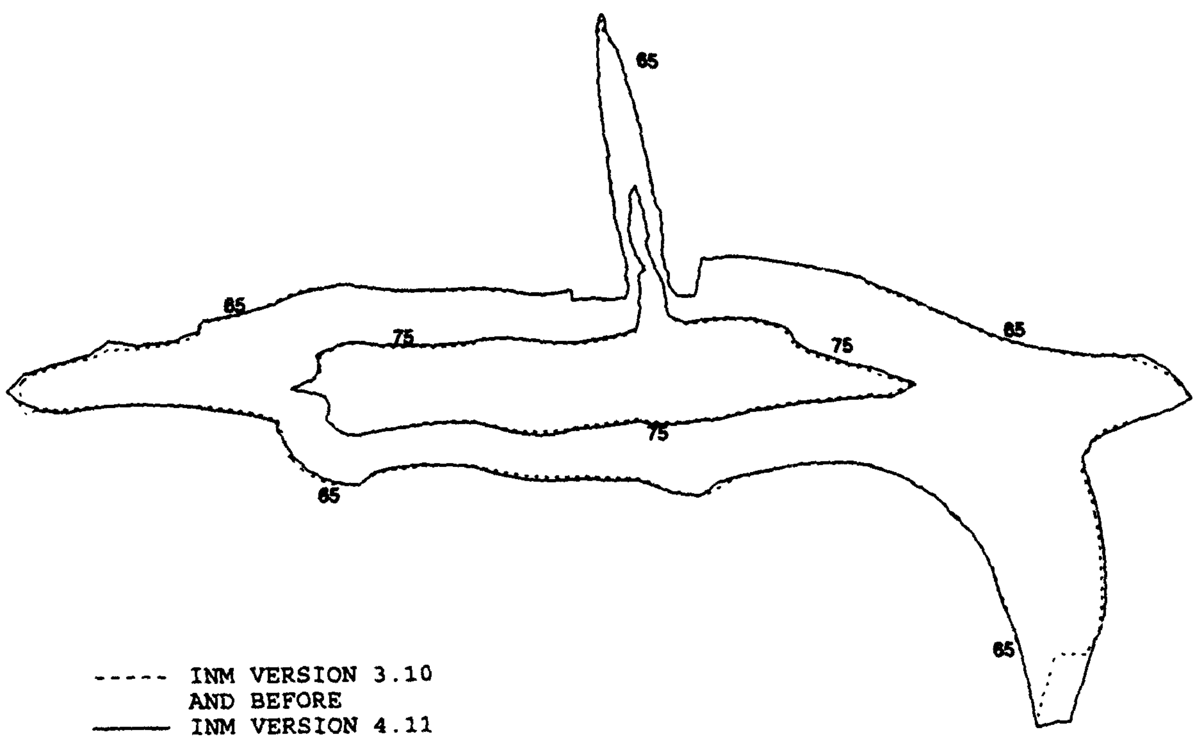

FIGURE A-4: LDN CONTOUR COMPARISON FOR INM INPUT TESTCASE

A.4 Data Base Number 11

Data Base Number 11 has been created through modifications, consisting primarily of the removal of artifacts from previous versions of the Data Base, and the addition of six new airplanes. As discussed in Section 2.1, Data Base Number 11 was expanded to include airplane performance coefficients and standard flight procedures required for use with the takeoff profile generator. With the exception of INM airplane numbers 1, 6, 7, 8, 10, 24, 56, 100, 101, and four of the new airplanes discussed below, procedures and coefficients required for profile generation are included in the Data Base. For those airplanes without standard flight procedures and coefficients, the takeoff profile for standard conditions is utilized regardless of airport elevation and temperature.

In addition, six new airplanes have been added to Data Base Number 11 (See Table A-1). They include the MD11 with the CF6-80C2D1F and PW4460 engines (INM numbers 102 and 103, respectively), the F-16A with the F100-PW-200 engine (INM number 104), and the F-16C/D with the F110-GE-100, F100-PW-220, and F100-PW-229 engines (INM numbers 105, 106 and 107, respectively). The Noise-Power-Distance (NPD) data, standard-day profiles, performance coefficients and standard flight procedures included in the Data Base for the MD11 airplanes were obtained from the McDonnell Douglas Corporation.

The Volpe Center extracted the NPD data for the F-16 airplanes from the United States Air Force's (USAF) data base which is part of their NOISEMAP suite of computer programs. NOISEMAP, the military counterpart of the INM, is used for predicting noise exposure around airports dominated by military operations. The USAF data were normalized to an airspeed of 160 knots and adjusted for the effect of duration consistent with the procedures for developing the INM data base. The standard-day profiles, which are the same for the four F-16 airplanes, were also extracted from the USAF's data base. They are considered typical for transient F-16 airplanes. However, due to significantly varying takeoff procedures for F-16 airplanes throughout the world a user-defined takeoff profile may be more appropriate.

TABLE A-1: INM VERSION 4.11 DATA BASE AIRPLANE DEFINITIONS

Airplane			Category	Noise		Apprh	Takeoff Profiles by Trip Length (nm)						
#	Name	Description	Name	#	Name	#	0-500	500-1000	1000-1500	1500-2500	2500-3500	3500-4500	over 4500
102	MD11GE	MD-11/CF6-80C2D1F	JCOM	68	2CF68D	102	374	375	376	377	378	379	380
103	MD11PW	MD-11/PW 4460	JCOM	69	PW4460	103	381	382	383	384	385	386	387
104	F16A	F-16A/PW-200	JMIL	70	PW200	104	388	0	0	0	0	0	0
105	F16GE	F-16C/D/GE-100	JMIL	71	GE100	105	389	0	0	0	0	0	0
106	F16PW0	F-16C/D/PW-220	JMIL	72	PW220	106	390	0	0	0	0	0	0
107	F16PW9	F-16C/D/PW-229	JMIL	73	PW229	107	391	0	0	0	0	0	0

A.5 References

[1] Horonjeff, R.D., Analysis of Aircraft Noise Levels in the Vicinity of Start-of-Takeoff Roll at Baltimore-Washington International Airport, Report No. FAA-EE-92-01, Lexington, MA: Harris Miller Miller & Hanson Inc., May 1992.

[2] Brown-Buntin Associates, "Letter Report, Noise Contour Adjustments - McCarran International Airport, Las Vegas - Unpublished Data", August 1993.

APPENDIX B

TAKEOFF PROFILE GENERATOR

This Appendix presents a technical discussion of the takeoff profile generator within INM Version 4.11. The discussion, based on the algorithms of SAE/AIR 1845 and the aerodynamic coefficients and standard flight procedures in Data Base Number 11, is presented in two sections. The first section describes the computation of individual takeoff profile segments under standard conditions, i.e., airport temperature of 59°F and airport elevation of zero ft Above Mean Sea Level (MSL). The second section describes the computation of individual takeoff profile segments under non-standard conditions.

The horizontal distance and altitude increments computed for each acceleration segment at standard conditions are utilized for segment computations at non-standard conditions. In fact, the altitude Above Ground Level (AGL) at the end point of each segment is the same for the non-standard and standard profiles. However, for the non-standard case, the ground roll length of the takeoff segment and the flight angles of the airborne segments are modified in response to the user-defined airport conditions using the equations described below. The non-standard computations are achieved by: (1) an introduction of a specially developed routine for computation of atmospheric coefficients at a given altitude MSL as a function of the airport temperature and elevation; and (2) development of a routine for the automated adjustment of the rate-of-climb for acceleration segments due to atmospheric conditions. With the atmospheric coefficients and the rates-of-climb controlled by the user-defined airport elevation and temperature, the SAE equations remain intact.

The takeoff profile generator has been tested for non-standard temperatures from -10 to 100°F and airport elevations up to 6000 ft MSL. Accordingly, the third section of this Appendix presents a set of tables which summarize the runway requirements and operational boundaries of the takeoff profile generator for various combinations of airport elevation and temperature (Tables B-1 through B-9).

B.1 Standard Conditions (15°C, Zero ft MSL)

This section describes the computation of a standard-condition takeoff profile on a segment-by-segment basis. The Subscripts 1 and 2 refer to the beginning and end of the segment, respectively. The following definitions, constants, and ratios apply to all computations described herein:

Gravitational Constant:	g	=	32.17
Thermal Gas Constant:	R_c	=	1716.2
Temperature Lapse Rate:	L	=	0.003566 °F/ft or °R/ft

Standard Temperature, °F:	T_{fap}	=	T_{f0}	=	59.0
Standard Temperature, °C:	T_{cap}	=	T_{c0}	=	15.0
Standard Temperature, °R:	T_{rap}	=	T_{r0}	=	518.67
Temperature Ratio:	THETA	=	$1-[(L)(H_x)/T_{r0}]$, where H_x is the altitude MSL for segment point X		
Pressure Ratio:	DELTA	=	$THETA^{[g/((Rc)(L))]}$		
Density Ratio:	SIGMA	=	$THETA^{[(g/((Rc)(L)))-1]}$		
Airport Elevation MSL:	H_{ap}	=	0.0 ft		
Brake Release Gross Weight		=	W		
Number of Engines supplying Thrust		=	N		

GROUND ROLL SEGMENT

For the ground roll segment the following apply:

Airport Temperature:	T_{c1}	=	T_{c2}	=	T_{cap}
Pressure Altitude MSL:	H_1	=	H_2	=	H_{ap}
Initial Calibrated Airspeed:	V_{c1}	=	16.0 kts		

Given the above, the remaining parameters for the ground roll segment are computed as follows:

Initial Thrust:	Th_1	=	$E + F(V_{c1}) + G_1(H_1) + G_2(H_1)^2 + H(T_{c1})$
Final Calibrated Airspeed:	V_{c2}	=	$(C)(W)^{1/2}$
Final Airplane True Speed:	V_{t2}	=	$V_{c2}/(SIGMA)^{1/2}$
Final Thrust:	Th_2	=	$E + F(V_{c2}) + G_1(H_2) + G_2(H_2)^2 + H(T_{c2})$
Segment Horizontal Length:	S_g	=	$[(B)(THETA)(W/DELTA)^2]/[(N)Th_2]$

where E, F, G_1, G_2, and H are engine-dependent coefficients from Data Base Number 11 for maximum takeoff thrust mode;

C is a coefficient from Data Base Number 11 which is appropriate to the takeoff flap/slat setting;

B is a coefficient from Data Base Number 11 which is appropriate to a specific airplane/flap-deflection combination, and varies only with the takeoff flap/slat setting; and

SIGMA, THETA, and DELTA, defined above, are constants equal to 1 at sea level.

CLIMB SEGMENT

For climb segments the following apply:

Initial Calibrated Airspeed:	V_{c1}	=	V_{c2} of the previous segment
Final Calibrated Airspeed:	V_{c2}	=	V_{c1}
Initial Thrust:	Th_1	=	Th_2 of the previous segment
Initial Temperature:	T_{c1}	=	T_{c2} of the previous segment
Initial Pressure Altitude MSL:	H_1	=	H_2 of the previous segment
Final Segment Altitude AGL:	Alt_{end}	=	As specified in the standard flight procedure

Given the above, the remaining parameters for the climb segment are computed as follows:

Final Segment Altitude MSL:	H_2	=	$Alt_{end} + H_{ap}$
Average Segment Altitude:	H_{avg}	=	$0.5(H_1 + H_2)$
Final Segment Temperature:	T_{c2}	=	$[(T_{fap} - L(H_2)) - 32](5/9)$
Average Segment Temperature:	T_{cavg}	=	$[(T_{fap} - L(H_{avg})) - 32](5/9)$
Average Calibrated Airspeed:	V_{cavg}	=	$V_{c1} = V_{c2}$
Average Segment Thrust:	Th_{avg}	=	$E + F(V_{cavg}) + G_1(H_{avg}) + G_2(H_{avg})^2 + H(T_{cavg})$
Average Airplane Weight:	W_{avg}	=	$W/\{[THETA]^{[g/((Rc)(L))]}\}$
Sine of the Flight Angle:	SIN_{ang}	=	$k\{[(N)(Th_{avg}/W_{avg})] - R\}$

where k = 1.01 for $V_{cavg} \le 200$; and
= 0.95 for $V_{cavg} > 200$

Cosine of the Flight Angle:	COS_{ang}	=	$(1 - SIN_{ang}^2)^{1/2}$
Horizontal Segment Distance:	S_g	=	$(H_2 - H_1)/(SIN_{ang}/COS_{ang})$
Final Segment Thrust:	Th_2	=	$E + F(V_{c2}) + G_1(H_2) + G_2(H_2)^2 + H(T_{c2})$
Final True Speed:	V_{t2}	=	$V_{c2}/(SIGMA)^{1/2}$

where E, F, G_1, G_2, and H are engine-dependent coefficients from Data

Base Number 11 for the thrust mode defined in the standard takeoff procedure; and

R is a coefficient from Data Base Number 11 which is the non-dimensional ratio of the airplane's drag coefficient to lift coefficient for a given flap setting and airplane configuration. The landing gear is assumed to be retracted.

ACCELERATION SEGMENT

For acceleration segments the following apply:

Initial Calibrated Airspeed:	V_{c1}	=	V_{c2} of the previous segment
Initial Airplane True Speed:	V_{t1}	=	V_{t2} of the previous segment
Initial Thrust:	Th_1	=	Th_2 of the previous segment
Initial Temperature:	T_{c1}	=	T_{c2} of the previous segment
Initial Pressure Altitude MSL:	H_1	=	H_2 of the previous segment
Final Calibrated Airspeed:	V_{c2}	=	As specified in the standard flight procedure
Rate-of-Climb:	V_{t2}	=	As specified in the standard *flight procedure*

Given the above, computation of the remaining parameters is performed using an iterative procedure to arrive at the altitude increment, DelH. If the difference between DelH and $DelH_c$ (the computed altitude increment for the current iteration) is greater than one ft, DelH is set equal to $DelH_c$, and the iterative process is repeated until a difference of one ft or less is achieved.

Initial Assumed Altitude Increment:	DelH	=	250 ft

<u>Start of Iterative Loop</u>:

Final Segment Altitude MSL:	H_2	=	$H_1 + DelH$
Final Segment Temperature:	T_{c2}	=	$\{[T_{fap} - L(H_2)] - 32\}(5/9)$
Final True Speed:	V_{t2}	=	$V_{c2}/(SIGMA)^{1/2}$
Final Segment Thrust:	Th_2	=	$E + F(V_{c2}) + G_1(H_2) + G_2(H_2)^2 + H(T_{c2})$
Average Segment Thrust:	Th_{avg}	=	$0.5(Th_1 + Th_2)$
Average True Speed:	V_{tavg}	=	$0.5(V_{t1} + V_{t2})$

Average Segment Altitude: $H_{avg} = H_1 + 0.5DelH$

Average Airplane Weight: $W_{avg} = W/\{[THETA]^{[g/((Rc)(L))]}\}$

Sine of the Flight Angle: $SIN_{ang} = V_{t2}/(101.2686V_{tavg})$

Flight Angle: $GAMMA = \arcsin(SIN_{ang})$

Horizontal Segment Distance: $S_g = \dfrac{0.042062(V_{t2}^2 - V_{t1}^2)}{[(N)(Th_{avg})/W_{avg}] - R_{avg} - SIN_{ang}}$

Computed Altitude Increment: $DelH_c = S_g[\tan(GAMMA)](1/0.95)$

Deviation of the Computed Altitude Increment from the Altitude Increment Assumed at the Start of the Current Iteration Cycle $DEV = abs[DelH_c - DelH]$

At this point the status of the iterative process is checked. If DEV is less than 1 ft, then the iterative process is complete. Otherwise,

Altitude Increment: $DelH = DelH_c$

and the iterative process is repeated as above.

where E, F, G_1, G_2, and H are engine-dependent coefficients from Data Base Number 11 for the thrust mode defined in the standard takeoff procedure; and

R_{avg} is a coefficient from Data Base Number 11 which is the non-dimensional ratio of the airplane's drag coefficient to lift coefficient for a given flap setting and airplane configuration. The landing gear is assumed to be retracted.

THRUST REDUCTION SEGMENT

A thrust reduction segment of 1000 ft (horizontal distance) is introduced to allow for a smooth transition of the thrust associated with the Federal Aviation Regulations, Part 36 thrust cutback point. This segment replaces the first 1000 ft of horizontal distance of the next segment which may be either a climb or an acceleration segment. Computation of the parameters associated with the thrust reduction segment and the next segment is performed simultaneously. For the thrust reduction segment the following apply:

Initial Calibrated Airspeed: $V_{c1} = V_{c2}$ of the previous segment

Initial Pressure Altitude MSL: $H_1 = H_2$ of the previous segment

Initial Temperature: $T_{c1} = T_{c2}$ of the previous segment

Initial Thrust: Th_{r1} = Th_2 of the previous segment

Initial Airplane True Speed: V_{t1} = V_{t2} of the previous segment

Horizontal Distance of the Thrust Reduction Segment: S_r = 1000 ft

Given the above, the final thrust for the cutback segment is computed as follows:

Thrust: $Th_{r2} = E + F(V_{c1}) + G_1(H_1) + G_2(H_1)^2 + H(T_{c1})$

where E, F, G1, G2, and H are engine-dependent coefficients from Data Base Number 11 for the thrust mode defined in the standard takeoff procedure.

Thrust Reduction Followed by an Acceleration Segment:

When the thrust reduction segment is followed by an acceleration segment, the initial thrust of the acceleration segment is set equal to Th_{r2} and computation of the remaining parameters associated with the acceleration segment is performed as described previously. The remaining parameters of the thrust reduction segment are computed as follows and the thrust reduction segment replaces the first 1000 ft of the acceleration segment:

True Speed at the end of the thrust reduction segment: $V_{tr2} = V_{t1} + (V_{t2} - V_{t1})(1000/S_g)$

Segment Altitude MSL at the end of the thrust reduction segment: $H_{r2} = H_1 + DelH(1000/S_g)$

where V_{t2}, S_g, and DelH are parameters computed above for an acceleration segment.

Thrust Reduction Followed by a Climb Segment:

When the thrust reduction segment is followed by a climb segment, the initial thrust of the climb segment is set equal to Th_{r2} and computation of the remaining parameters associated with the climb segment is performed as described previously. The remaining parameters for the thrust reduction segment are computed as follows and the thrust reduction segment replaces the first 1000 ft of the climb segment:

True Speed at the end of the thrust reduction segment: $V_{tr} = V_{t1} = V_{t2}$

Segment Altitude MSL at the end of the thrust reduction segment: $H_r = H_1 + (H_2 - H_1)(1000/S_g)$

where V_{t2}, H_2 and S_g are parameters computed above for a climb segment.

EXCEPTIONS

The above computations assume the airplane is jet-powered and that the required thrust computations are performed in lbs-thrust. However, if the airplane is propeller-powered the following parameters are factored into the above computations: (1) propeller efficiency and installed net propulsive power for maximum takeoff thrust; and (2) propeller efficiency and installed net propulsive power for maximum climb thrust. In addition, for a select few airplanes, the thrust for a particular segment is given in the standard flight procedure as fixed and as such is not computed by the takeoff profile generator. Finally, for airplanes in Data Base Number 11 for which thrust is expressed in percent-RPM, an intermediate computation is performed to convert to lbs-thrust.

B.2 Non-Standard Conditions

This section describes the computation of a non-standard-condition takeoff profile on a segment-by-segment basis. Non-standard conditions exist when either the airport elevation is not zero ft MSL and/or the airport temperature is not standard at the airport elevation. The following definitions, constants, and ratios, based upon the concept of density altitude, supplement those described for standard conditions and apply to all computations described herein:

Gravitational Constant:	g	=	32.17
Thermal Gas Constant:	R_c	=	1716.2
Temperature Lapse Rate:	L	=	0.003566 °F/ft or °R/ft
Airport Elevation MSL:	H_{ap}	=	User-defined in ft
Non-Standard Temperature at Airport Elevation:	T_{fap}	=	User-defined degrees F
Standard Temperature, °R:	T_{r0}	=	518.67
Standard Temperature Lapsed to Airport Elevation, °R:	T_{rap}	=	T_{r0} - (L) (H_{ap})
Temperature at Altitude, °R:	T_r	=	T_{rap} - [(L) (H_x - H_{ap})]; where H_x is the altitude MSL for segment point X
Standard Air Pressure:	P_0	=	2116
Standard Air Pressure at Altitude:	P	=	(P_0) (DELTA)
Standard Air Density:	R_0	=	0.002328
Air Density at Altitude:	R	=	P/[(R_c) (T_r)]
Non-Standard Density Ratio:	$SIGMA_{ns}$	=	R/R_0

Non-Standard Temperature Ratio:	$THETA_{ns} =$	$SIGMA_{ns}^{(1/\{g/[(Rc)(L)-1]\})}$
Non-Standard Pressure Ratio:	$DELTA_{ns} =$	$THETA_{ns}^{\{g/[(Rc)(L)]\}}$

GROUND ROLL SEGMENT

For the ground roll segment the following apply:

Airport Temperature:	T_{c1}	=	T_{c2}	=	$(T_{fap} - 32)(5/9)$
Pressure Altitude MSL:	H_1	=	H_2	=	H_{ap}
Initial Calibrated Airspeed:	V_{c1}	=	16.0 kts		

Given the above, the remaining parameters for the ground roll segment under non-standard conditions are computed as in Section B.1, Standard Conditions, using the non-standard THETA, SIGMA, and DELTA, as appropriate.

CLIMB SEGMENT

The parameters for the climb segment under non-standard conditions are computed as in Section B.1, Standard Conditions, using the non-standard THETA, SIGMA, and DELTA, as appropriate.

ACCELERATION SEGMENT

With the exception of the iterative process described below, the parameters for the acceleration segment under non-standard conditions are computed as in Section B.1, Standard Conditions, using the non-standard THETA, SIGMA, and DELTA, as appropriate.

Computation of the remaining parameters is performed using an iterative procedure to arrive at the horizontal distance of the segment, S_{gns}. If the difference between S_{gns} and S_{gc} (the computed horizontal distance for the current iteration) is greater than ten ft, S_{gns} is set equal to the arithmetic average of S_{gns} and S_{gc}, and the iterative process is repeated until a difference of ten ft or less is achieved.

Initial Assumed Horizontal Distance:	S_{gns}	=	S_g computed for standard conditions

The equations for the acceleration segment under standard conditions are used to supplement the following non-standard computations:

<u>Start of Iterative Loop</u>:

Tangent of the Flight Angle:	$TAN_{ang} =$	$0.95(DelH/S_{gns})$

Sine of the Flight Angle: $SIN_{ang} = \sin[\arctan(TAN_{ang})]$

Computed Horizontal Distance:

$$S_{gc} = \frac{(\frac{1}{2}g)(0.95)(V_{t2}^2 - V_{t1}^2)}{[N(Th_{avg})] - R_{avg} - SIN_{ang}}$$

Deviation of the Computed Horizontal Distance from the Horizontal Distance Assumed at the Start of the Current Iteration Cycle: $DEV = \mathrm{abs}[S_{gc} - S_{gns}]$

At this point the status of the iterative process is checked. If DEV is less than ten ft, then the iterative process is complete. Otherwise,

Horizontal Distance: $S_{gns} = 0.5[S_{gc} + S_{gns}]$

and the iterative process is repeated as above.

where E, F, G_1, G_2, and H are engine-dependent coefficients from Data Base Number 11 for the thrust mode defined in the standard takeoff procedure; and

R_{avg} is a coefficient from Data Base Number 11 which is the non-dimensional ratio of the airplane's drag coefficient to lift coefficient for a given flap setting and airplane configuration. The landing gear is assumed to be retracted.

THRUST REDUCTION SEGMENT

The parameters for the thrust reduction segment under non-standard conditions are computed as in Section B.1, Standard Conditions, using the non-standard THETA, SIGMA, and DELTA, as appropriate.

ERROR CHECKING

The non-standard portion of the profile generator maintains several built-in error checks which guard against the computation of improper takeoff profiles. Computation of takeoff profiles is not performed if any of the following conditions are detected:

(1) the computed flight angle for a climb segment is zero or negative;

(2) the computed horizontal distance for an acceleration segment is zero or negative;

(3) the number of iterations required to compute the horizontal distance of an acceleration segment exceeds five hundred; and

(4) the length of the computed ground roll segment exceeds the length of the runway by more than ten percent; if the computed segment exceeds the runway length by less than ten percent, the user is warned of the discrepancy as discussed in Section 2.1.

EXCEPTIONS

The exceptions noted in Section 2.1, Standard Conditions, also apply for non-standard conditions.

B.3 Runway Requirements/Operational Boundaries

Tables B-1 through B-9 present the length (ft) of the ground roll segment computed by the profile generator for all INM airplanes and stage weights. These tables are intended to give the user guidance on the operational boundaries and runway requirements of the profile generator for various airport temperatures, elevations, and runway lengths. These data are presented for nine combinations of airport elevation and temperature intended to cover the range of average yearly conditions at airports across the United States. Tables B-1 through B-3 present these data for 0 ft Above Mean Sea Level (MSL) elevation and three temperatures, 59°F, 40°F and 80°F, respectively. Tables B-4 through B-6 present these data for 3000 ft MSL elevation and three temperatures, 59°F, 40°F and 80°F, respectively. Tables B-7 through B-9 present these data for 6000 ft MSL elevation and three temperatures, 59°F, 40°F and 80°F, respectively. When the generator determines that a profile can not be computed, as discussed in Section B.2, Error Checking, a zero is inserted in the table, e.g., Table B-2, INM Airplane Number 71, Stage Weight 3.

TABLE B-1: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 59°F , ELEVATION 0 FT MSL

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
1	4358	4732	5223	5842	7545	7788	---
2	4624	5004	5400	6352	7630	9173	10579
3	3719	4057	4501	5067	6644	6871	---
4	2616	2926	3240	3752	4503	5309	6699
5	3846	4157	4481	5257	6297	7545	8679
6	4193	4671	5438	6551	8098	9433	---
7	3963	4429	5176	6263	7767	8547	---
8	2721	3189	3523	4193	4671	---	---
9	3279	3739	4160	4913	5992	7186	8080
10	2799	3128	3656	4424	5486	6037	---
11	2684	3034	3405	4006	4436	---	---
12	3000	3338	3879	4666	5754	6709	---
13	3705	4054	4607	5400	6483	7180	8167
14	3357	3684	4204	4956	5989	6660	7614
15	2693	3335	3959	---	---	---	---
16	3279	3739	4160	4913	5992	7186	8080
17	3705	4054	4607	5400	6481	7180	8167
18	6967	6967	8556	8556	9799	9799	---
19	3997	4389	4943	5838	6813	7868	---
20	3371	3656	3954	4609	5536	6575	7799
21	4669	5071	5463	6353	7614	9032	10657
22	5052	5383	5900	6443	7610	8883	---
23	4611	4897	5343	5811	6741	7747	8869
24	5968	6863	7821	8841	---	---	---
25	4513	5004	5522	6146	---	---	---
26	5460	6050	6913	8098	9476	---	---
27	5979	6964	8028	9074	---	---	---
28	4513	5004	5522	6146	---	---	---
29	5460	6050	6913	8098	9476	---	---
30	5263	6120	6965	7699	---	---	---
31	3352	3846	4285	5206	6369	---	---
32	3414	3703	4015	4587	5362	6268	6811
33	3020	3274	3549	4062	4765	5576	5970
34	3067	3467	3924	4411	5328	6299	---
35	3506	3981	4489	5506	---	---	---
36	3187	3681	4135	5041	---	---	---
37	4221	4827	5609	---	---	---	---
38	3292	4035	---	---	---	---	---
39	3184	3746	4612	---	---	---	---
40	3634	4416	5227	---	---	---	---
41	2124	2638	3133	---	---	---	---
42	3075	3310	3893	4618	---	---	---
43	3634	4416	5227	---	---	---	---
44	2124	2638	3133	---	---	---	---
45	3075	3310	3893	4618	---	---	---
46	3653	4186	4839	---	---	---	---
47	3303	3688	4096	4526	---	---	---
48	3897	4708	5601	---	---	---	---
49	3685	4155	4728	5991	---	---	---
50	4002	4548	5131	6493	---	---	---
51	2646	2846	3091	3573	4217	---	---
52	2747	2960	3219	3692	4376	5123	---
53	2826	---	---	---	---	---	---
54	2569	---	---	---	---	---	---
55	3689	---	---	---	---	---	---

TABLE B-1: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 59°F , ELEVATION 0 FT MSL (CONTINUED)

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
56	4136	---	---	---	---	---	---
57	3130	---	---	---	---	---	---
58	3498	---	---	---	---	---	---
59	3725	---	---	---	---	---	---
60	2972	---	---	---	---	---	---
61	4945	---	---	---	---	---	---
62	3898	---	---	---	---	---	---
63	2697	3397	4586	---	---	---	---
64	1794	---	---	---	---	---	---
65	1211	---	---	---	---	---	---
66	3860	4921	5883	---	---	---	---
67	2638	---	---	---	---	---	---
68	2560	---	---	---	---	---	---
69	1239	---	---	---	---	---	---
70	3181	4201	5396	---	---	---	---
71	1520	1856	2234	---	---	---	---
72	1792	2332	---	---	---	---	---
73	2082	---	---	---	---	---	---
74	632	---	---	---	---	---	---
75	738	---	---	---	---	---	---
76	1584	---	---	---	---	---	---
77	699	---	---	---	---	---	---
78	10532	---	---	---	---	---	---
79	4153	6477	---	---	---	---	---
80	5158	7065	---	---	---	---	---
81	4505	6732	---	---	---	---	---
82	5120	7651	---	---	---	---	---
83	3768	4193	4551	5313	6355	7861	9137
84	4084	4421	4756	5590	6711	8052	9291
85	3657	4252	4730	5769	---	---	---
86	3569	4125	4636	5657	---	---	---
87	2753	2985	3237	3708	4351	5096	5457
88	2942	3608	4350	---	---	---	---
89	3324	4085	4821	---	---	---	---
90	3187	3894	4678	---	---	---	---
91	11242	---	---	---	---	---	---
92	9308	---	---	---	---	---	---
93	3244	3596	4111	4820	5645	---	---
94	3004	3331	3676	4092	---	---	---
95	3062	---	---	---	---	---	---
96	4190	---	---	---	---	---	---
97	3640	4331	5158	5984	---	---	---
98	4136	---	---	---	---	---	---
99	2427	---	---	---	---	---	---
100	4513	5004	5522	6146	---	---	---
101	5460	6050	6913	8098	9476	---	---
102	3968	4287	4619	5445	6343	7459	8831
103	4202	4543	4899	5784	6749	7950	9430
104	3000	---	---	---	---	---	---
105	3000	---	---	---	---	---	---
106	3000	---	---	---	---	---	---
107	3000	---	---	---	---	---	---

TABLE B-2: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 40°F , ELEVATION 0 FT MSL

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
1	4358	4732	5223	5842	7545	7788	---
2	4254	4603	4968	5843	7020	8439	9733
3	3422	3732	4141	4662	6112	6322	---
4	2406	2692	2981	3451	4142	4884	6163
5	3538	3824	4122	4837	5793	6942	7984
6	4193	4671	5438	6551	8098	9433	---
7	3963	4429	5176	6263	7767	8547	---
8	2721	3109	3523	4193	4671	---	---
9	3017	3440	3827	4520	5512	6611	7434
10	2799	3128	3656	4424	5486	6037	---
11	2470	2791	3133	3686	4081	---	---
12	2760	3070	3569	4293	5294	6172	---
13	3409	3729	4238	4968	5964	6606	7514
14	3088	3389	3868	4559	5510	6127	7005
15	2478	3068	3642	---	---	---	---
16	3017	3440	3827	4520	5512	6611	7434
17	3409	3729	4238	4968	5964	6606	7514
18	6410	6410	7872	7872	9015	9015	---
19	3677	4038	4547	5371	6268	7239	---
20	3101	3364	3638	4260	5091	6049	7175
21	4295	4666	5026	5844	7005	8309	9804
22	4648	4952	5428	5928	7001	8172	---
23	4242	4505	4916	5346	6202	7127	8159
24	5968	6863	7821	8841	---	---	---
25	4152	4604	5080	5654	---	---	---
26	5023	5566	6360	7450	8718	---	---
27	5500	6407	7386	8347	---	---	---
28	4152	4604	5080	5654	---	---	---
29	5023	5566	6360	7450	8718	---	---
30	4842	5630	6408	7083	---	---	---
31	3084	3539	3942	4789	5860	---	---
32	3141	3407	3694	4220	4933	5767	6266
33	2778	3012	3265	3737	4384	5130	5492
34	2822	3189	3610	4058	4902	5795	---
35	3226	3663	4130	5065	---	---	---
36	2928	3382	3799	4631	---	---	---
37	3883	4440	5160	---	---	---	---
38	3029	3712	---	---	---	---	---
39	2930	3446	4243	---	---	---	---
40	3343	4062	4809	---	---	---	---
41	1954	2427	2883	---	---	---	---
42	2829	3045	3581	4249	---	---	---
43	3343	4062	4809	---	---	---	---
44	1954	2427	2883	---	---	---	---
45	2829	3045	3581	4249	---	---	---
46	3361	3851	4452	---	---	---	---
47	3038	3393	3768	4164	---	---	---
48	3585	4332	5153	---	---	---	---
49	3390	3822	4349	5512	---	---	---
50	3681	4184	4720	5974	---	---	---
51	2434	2619	2843	3287	3879	---	---
52	2526	2722	2961	3395	4024	4712	---
53	2600	---	---	---	---	---	---
54	2364	---	---	---	---	---	---
55	3394	---	---	---	---	---	---

TABLE B-2: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 40°F , ELEVATION 0 FT MSL (CONTINUED)

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
56	4136	---	---	---	---	---	---
57	2880	---	---	---	---	---	---
58	3218	---	---	---	---	---	---
59	3427	---	---	---	---	---	---
60	2734	---	---	---	---	---	---
61	4550	---	---	---	---	---	---
62	3586	---	---	---	---	---	---
63	2435	3068	4141	---	---	---	---
64	1651	---	---	---	---	---	---
65	1093	---	---	---	---	---	---
66	3485	4443	5312	---	---	---	---
67	2382	---	---	---	---	---	---
68	2311	---	---	---	---	---	---
69	1119	---	---	---	---	---	---
70	2873	3794	4872	---	---	---	---
71	1372	1676	0	---	---	---	---
72	1618	2106	---	---	---	---	---
73	1880	---	---	---	---	---	---
74	570	---	---	---	---	---	---
75	667	---	---	---	---	---	---
76	1431	---	---	---	---	---	---
77	632	---	---	---	---	---	---
78	9689	---	---	---	---	---	---
79	3820	5958	---	---	---	---	---
80	4746	6500	---	---	---	---	---
81	4068	6079	---	---	---	---	---
82	4624	0	---	---	---	---	---
83	3467	3858	4187	4888	5847	7232	8406
84	3757	4067	4376	5143	6174	7408	8547
85	3364	3912	4352	5307	---	---	---
86	3284	3795	4265	5204	---	---	---
87	2533	2746	2978	3411	4002	4688	5020
88	2707	3320	4002	---	---	---	---
89	3058	3758	4435	---	---	---	---
90	2932	3583	4304	---	---	---	---
91	10327	---	---	---	---	---	---
92	8563	---	---	---	---	---	---
93	2984	3308	3782	4434	5194	---	---
94	2764	3065	3382	3764	---	---	---
95	2817	---	---	---	---	---	---
96	3855	---	---	---	---	---	---
97	3349	3985	4745	5505	---	---	---
98	3805	---	---	---	---	---	---
99	2233	---	---	---	---	---	---
100	4513	5004	5522	6146	---	---	---
101	5460	6050	6913	8098	9476	---	---
102	3369	3639	3920	4618	5378	6321	7479
103	3501	3784	4079	4812	5611	6605	7827
104	3000	---	---	---	---	---	---
105	3000	---	---	---	---	---	---
106	3000	---	---	---	---	---	---
107	3000	---	---	---	---	---	---

TABLE B-3: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 80°F , ELEVATION 0 FT MSL

IDN #	STAGE WEIGHT						
	1	2	3	4	5	6	7
1	4358	4732	5223	5842	7545	7788	---
2	5053	5468	5901	6941	8338	10824	11561
3	4064	4433	4919	5537	7260	7509	---
4	2858	3198	3541	4100	4920	5801	7321
5	4202	4542	4896	5745	6881	8245	9484
6	4193	4671	5438	6551	8098	9433	---
7	3963	4429	5176	6263	7767	8547	---
8	2721	3109	3523	4193	4671	---	---
9	3583	4086	4545	5369	6548	7852	8830
10	2799	3128	3656	4424	5486	6037	---
11	2933	3315	372[illegible]	4378	4847	---	---
12	3278	3647	4239	5099	6288	7332	---
13	4049	4430	5034	5901	7084	7846	8925
14	3668	4025	4594	5415	6544	7277	8320
15	2943	3644	4326	---	---	---	---
16	3583	4086	4545	5369	6548	7852	8830
17	4049	4430	5034	5901	7084	7846	8925
18	7614	7614	9350	9350	10708	10708	---
19	4368	4797	5401	6380	7445	8598	---
20	3683	3995	4321	5037	6047	7185	8523
21	5102	5542	5970	6942	8321	9870	11646
22	5521	5882	6447	7041	8315	9707	---
23	5039	5351	5839	6350	7366	8465	9692
24	5968	6863	7821	8841	---	---	---
25	4932	5468	6034	6716	---	---	---
26	5967	6612	7554	8849	10355	---	---
27	6533	7610	8773	9915	---	---	---
28	4932	5468	6034	6716	---	---	---
29	5967	6612	7554	8849	10355	---	---
30	5751	6688	7611	8413	---	---	---
31	3663	4203	4683	5689	6960	---	---
32	3731	4047	4387	5012	5860	6850	7443
33	3300	3578	3878	4439	5207	6094	6524
34	3352	3788	4287	4820	5823	6883	---
35	3832	4351	4905	6016	---	---	---
36	3488	4029	4526	5518	---	---	---
37	4613	5274	6129	---	---	---	---
38	3598	4409	---	---	---	---	---
39	3480	4093	5040	---	---	---	---
40	3971	4825	5712	---	---	---	---
41	2321	2883	3424	---	---	---	---
42	3361	3617	4254	5047	---	---	---
43	3971	4825	5712	---	---	---	---
44	2321	2883	3424	---	---	---	---
45	3361	3617	4254	5047	---	---	---
46	3992	4574	5288	---	---	---	---
47	3609	4030	4476	4946	---	---	---
48	4258	5145	6121	---	---	---	---
49	4027	4540	5166	6547	---	---	---
50	4373	4970	5607	7095	---	---	---
51	2891	3111	3377	3904	4608	---	---
52	3002	3236	3519	4036	4783	5600	---
53	3088	---	---	---	---	---	---
54	2808	---	---	---	---	---	---
55	4031	---	---	---	---	---	---

TABLE B-3: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 80°F , ELEVATION 0 FT MSL (CONTINUED)

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
56	4136	---	---	---	---	---	---
57	3421	---	---	---	---	---	---
58	3823	---	---	---	---	---	---
59	4071	---	---	---	---	---	---
60	3248	---	---	---	---	---	---
61	5404	---	---	---	---	---	---
62	4260	---	---	---	---	---	---
63	3806	3787	5111	---	---	---	---
64	1961	---	---	---	---	---	---
65	135	---	---	---	---	---	---
66	4302	5485	6558	---	---	---	---
67	2941	---	---	---	---	---	---
68	2853	---	---	---	---	---	---
69	1381	---	---	---	---	---	---
70	3546	4683	6014	---	---	---	---
71	1694	2069	0	---	---	---	---
72	1997	2599	---	---	---	---	---
73	2321	---	---	---	---	---	---
74	704	---	---	---	---	---	---
75	823	---	---	---	---	---	---
76	1766	---	---	---	---	---	---
77	780	---	---	---	---	---	---
78	11509	---	---	---	---	---	---
79	4538	7077	---	---	---	---	---
80	5637	7720	---	---	---	---	---
81	5022	7504	---	---	---	---	---
82	5707	8528	---	---	---	---	---
83	4118	4582	4973	5806	6945	8590	9984
84	4463	4831	5197	6109	7334	8799	10152
85	3996	4646	5169	6304	---	---	---
86	3901	4508	5066	6182	---	---	---
87	3009	3262	3537	4052	4754	5569	5963
88	3215	3943	4754	---	---	---	---
89	3633	4464	5268	---	---	---	---
90	3483	4255	5112	---	---	---	---
91	12306	---	---	---	---	---	---
92	10171	---	---	---	---	---	---
93	3544	3929	4493	5267	6169	---	---
94	3283	3640	4017	4472	---	---	---
95	3346	---	---	---	---	---	---
96	4579	---	---	---	---	---	---
97	3978	4733	5637	6539	---	---	---
98	4520	---	---	---	---	---	---
99	2652	---	---	---	---	---	---
100	4513	5004	5522	6146	---	---	---
101	5460	6050	6913	8098	9476	---	---
102	4777	5163	5564	6563	7651	9004	10667
103	5189	5613	6055	7156	8358	9858	11708
104	3000	---	---	---	---	---	---
105	3000	---	---	---	---	---	---
106	3000	---	---	---	---	---	---
107	3000	---	---	---	---	---	---

TABLE B-4: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 59°F , ELEVATION 3000 FT MSL

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
1	4358	4732	5223	5842	7545	7788	---
2	5750	6222	6714	7895	9482	11396	13139
3	4627	5046	5598	6301	8257	8540	---
4	3255	3641	4031	4667	5600	6601	8327
5	4691	5069	5464	6409	7673	9191	10569
6	4193	4671	5438	6551	8098	9433	---
7	3963	4429	5176	6263	7767	8547	---
8	2721	3109	3523	4193	4671	---	---
9	4028	4593	5109	6032	7355	8818	9913
10	2799	3128	3656	4424	5486	6037	---
11	3328	3761	4221	4965	5497	---	---
12	3848	4281	4976	5985	7382	8607	---
13	4748	5195	5904	6921	8308	9202	10467
14	4136	4537	5177	6101	7371	8195	9367
15	3403	4213	0	---	---	---	---
16	4028	4593	5109	6032	7355	8818	9913
17	4748	5195	5904	6921	8308	9202	10467
18	8684	8684	10661	10661	12208	12208	---
19	5160	5666	6381	7537	8797	10160	---
20	4130	4479	4844	5645	6775	8047	9543
21	6001	6519	7022	8166	9788	11612	13700
22	6265	6674	7315	7987	9429	11004	---
23	5744	6100	6655	7236	8393	9643	11038
24	5968	6863	7821	8841	---	---	---
25	5823	6457	7125	7930	---	---	---
26	6755	7485	8551	10015	11718	---	---
27	7666	8929	10294	11634	---	---	---
28	5823	6457	7125	7930	---	---	---
29	6755	7485	8551	10015	11718	---	---
30	6521	7582	8629	9537	---	---	---
31	4324	4961	5528	6716	8218	---	---
32	4196	4550	4933	5634	6585	7695	8360
33	3606	3909	4236	4848	5684	6649	7117
34	3605	4072	4607	5177	6249	7383	---
35	4159	4721	5320	6520	---	---	---
36	3926	4534	5092	6206	---	---	---
37	5428	6207	7212	---	---	---	---
38	4081	5000	---	---	---	---	---
39	3965	4663	5741	---	---	---	---
40	4651	5651	6690	---	---	---	---
41	2712	3368	4001	---	---	---	---
42	3957	4259	5009	5943	---	---	---
43	4651	5651	6690	---	---	---	---
44	2712	3368	4001	---	---	---	---
45	3957	4259	5009	5943	---	---	---
46	4674	5355	6191	---	---	---	---
47	4094	4571	5076	5608	---	---	---
48	4795	5792	6889	---	---	---	---
49	4548	5128	5834	7391	---	---	---
50	5029	5715	6447	8157	---	---	---
51	3259	3506	3806	4399	5191	---	---
52	3287	3541	3851	4414	5229	6119	---
53	3377	---	---	---	---	---	---
54	3281	---	---	---	---	---	---
55	4770	---	---	---	---	---	---

TABLE B-4: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 59°F , ELEVATION 3000 FT MSL (CONTINUED)

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
56	4136	---	---	---	---	---	---
57	3647	---	---	---	---	---	---
58	4240	---	---	---	---	---	---
59	4790	---	---	---	---	---	---
60	3458	---	---	---	---	---	---
61	5994	---	---	---	---	---	---
62	4798	---	---	---	---	---	---
63	3261	4108	5545	---	---	---	---
64	2156	---	---	---	---	---	---
65	1464	---	---	---	---	---	---
66	4667	5951	7115	---	---	---	---
67	3191	---	---	---	---	---	---
68	3095	---	---	---	---	---	---
69	1499	---	---	---	---	---	---
70	3847	5081	6525	---	---	---	---
71	1838	2245	0	---	---	---	---
72	2167	2820	---	---	---	---	---
73	2518	---	---	---	---	---	---
74	764	---	---	---	---	---	---
75	893	---	---	---	---	---	---
76	1916	---	---	---	---	---	---
77	846	---	---	---	---	---	---
78	13454	---	---	---	---	---	---
79	5094	7944	---	---	---	---	---
80	6328	8665	---	---	---	---	---
81	5448	6141	---	---	---	---	---
82	6192	9252	---	---	---	---	---
83	4637	5160	5599	6535	7815	9662	11228
84	5043	5459	5872	6900	8281	9932	11457
85	4503	5235	5823	7099	---	---	---
86	4233	4890	5494	6698	---	---	---
87	3464	3755	4071	4664	5471	6408	6861
88	3717	0	0	---	---	---	---
89	3949	4849	5718	---	---	---	---
90	4008	4896	5881	---	---	---	---
91	13820	---	---	---	---	---	---
92	11445	---	---	---	---	---	---
93	4029	4466	5106	5985	7008	---	---
94	3800	4214	4650	5176	---	---	---
95	3660	---	---	---	---	---	---
96	5268	---	---	---	---	---	---
97	4698	5591	6659	7725	---	---	---
98	5066	---	---	---	---	---	---
99	2913	---	---	---	---	---	---
100	4513	5004	5522	6146	---	---	---
101	5460	6050	6913	8098	9476	---	---
102	4968	5367	5783	6816	7939	9335	11051
103	5183	5603	6041	7131	8318	9796	11616
104	3000	---	---	---	---	---	---
105	3000	---	---	---	---	---	---
106	3000	---	---	---	---	---	---
107	3000	---	---	---	---	---	---

TABLE B-5: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 40°F , ELEVATION 3000 FT MSL

IDN #	STAGE WEIGHT						
	1	2	3	4	5	6	7
1	4358	4732	5223	5842	7565	7788	---
2	5290	5724	6176	7263	8723	10484	12088
3	4256	4642	5150	5796	7597	7857	---
4	2995	3350	3709	4293	5152	6073	7661
5	4315	4664	5027	5896	7059	8456	9723
6	4193	4671	5438	6551	8098	9433	---
7	3963	4429	5176	6263	7767	8547	---
8	2721	3109	3523	4193	4671	---	---
9	3706	4226	4700	5550	6767	8112	9120
10	2799	3128	3656	4426	5486	6037	---
11	3062	3460	3884	4568	5057	---	---
12	3540	3939	4578	5506	6791	7918	---
13	4368	4780	5432	6367	7643	8466	9630
14	3805	4174	4763	5613	6781	7539	8617
15	3130	3875	0	---	---	---	---
16	3706	4226	4700	5550	6767	8112	9120
17	4368	4780	5432	6367	7643	8466	9630
18	7989	7989	9808	9808	11231	11231	---
19	4747	5213	5870	6934	8093	9347	---
20	3799	4121	4456	5193	6233	7403	8779
21	5521	5997	6460	7513	9005	10682	12604
22	5764	6140	6729	7348	8675	10124	---
23	5284	5611	6122	6657	7721	8871	10154
24	5968	6863	7821	8841	---	---	---
25	5357	5940	6554	7295	---	---	---
26	6215	6886	7867	9214	10780	---	---
27	7052	8215	9470	10703	---	---	---
28	5357	5940	6554	7295	---	---	---
29	6215	6886	7867	9214	10780	---	---
30	5999	6976	7938	8774	---	---	---
31	3978	4564	5086	6179	7560	---	---
32	3860	4186	4538	5183	6058	7079	7691
33	3317	3596	3897	4460	5229	6117	6547
34	3316	3746	4238	4763	5749	6792	---
35	3826	4343	4895	5998	---	---	---
36	3607	4165	4678	5701	---	---	---
37	4994	5710	6635	---	---	---	---
38	3754	4600	---	---	---	---	---
39	3648	4290	5282	---	---	---	---
40	4279	5199	6155	---	---	---	---
41	2495	3099	3681	---	---	---	---
42	3640	3918	4608	5467	---	---	---
43	4279	5199	6155	---	---	---	---
44	2495	3099	3681	---	---	---	---
45	3640	3918	4608	5467	---	---	---
46	4300	4927	5696	---	---	---	---
47	3766	4206	4670	5160	---	---	---
48	4411	5329	6337	---	---	---	---
49	4184	4717	5367	6799	---	---	---
50	4626	5257	5931	7505	---	---	---
51	2998	3225	3502	4047	4775	---	---
52	3023	3257	3542	4060	4809	5628	---
53	3107	---	---	---	---	---	---
54	3019	---	---	---	---	---	---
55	4388	---	---	---	---	---	---

TABLE B-5: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 40°F , ELEVATION 3000 FT MSL (CONTINUED)

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
56	4136	---	---	---	---	---	---
57	3355	---	---	---	---	---	---
58	3901	---	---	---	---	---	---
59	4407	---	---	---	---	---	---
60	3181	---	---	---	---	---	---
61	5514	---	---	---	---	---	---
62	4414	---	---	---	---	---	---
63	2945	3710	5007	---	---	---	---
64	1983	---	---	---	---	---	---
65	1322	---	---	---	---	---	---
66	4214	5373	6424	---	---	---	---
67	2881	---	---	---	---	---	---
68	2795	---	---	---	---	---	---
69	1353	---	---	---	---	---	---
70	3474	4588	5892	---	---	---	---
71	1660	2027	0	---	---	---	---
72	1957	2546	---	---	---	---	---
73	2274	---	---	---	---	---	---
74	690	---	---	---	---	---	---
75	806	---	---	---	---	---	---
76	1730	---	---	---	---	---	---
77	764	---	---	---	---	---	---
78	12377	---	---	---	---	---	---
79	4686	7308	---	---	---	---	---
80	5822	7972	---	---	---	---	---
81	4920	7351	---	---	---	---	---
82	5591	8354	---	---	---	---	---
83	4266	4747	5151	6012	7189	8889	10329
84	4639	5022	5402	6348	7618	9137	10540
85	4143	4816	5357	6531	---	---	---
86	3895	4499	5054	6162	---	---	---
87	3186	3455	3745	4290	5033	5895	6312
88	3420	4193	0	---	---	---	---
89	3633	4461	5261	---	---	---	---
90	3687	4505	5411	---	---	---	---
91	12695	---	---	---	---	---	---
92	10529	---	---	---	---	---	---
93	3706	4108	4697	5506	6448	---	---
94	3496	3877	4278	4762	---	---	---
95	3367	---	---	---	---	---	---
96	4846	---	---	---	---	---	---
97	4322	5143	6126	7107	---	---	---
98	4661	---	---	---	---	---	---
99	2680	---	---	---	---	---	---
100	4513	5004	5522	6146	---	---	---
101	5460	6050	6913	8098	9476	---	---
102	4224	4563	4915	5790	6742	7923	9374
103	4333	4683	5047	5953	6939	8166	9675
104	3000	---	---	---	---	---	---
105	3000	---	---	---	---	---	---
106	3000	---	---	---	---	---	---
107	3000	---	---	---	---	---	---

TABLE B-6: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 80°F , ELEVATION 3000 FT MSL

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
1	4358	4732	5223	5842	7545	7788	-
2	6283	6799	7336	8628	10362	12453	14358
3	5056	5514	6117	6885	9023	9332	---
4	3557	3979	4405	5100	6120	7213	9099
5	5126	5540	5971	7003	8385	10044	11549
6	4193	4671	5438	6551	8098	9433	---
7	3963	4429	5176	6263	7767	8547	---
8	2721	3109	3523	4193	4671	---	---
9	4402	5020	5583	6592	8037	9636	10833
10	2799	3128	3656	4424	5486	6037	---
11	3637	4110	4613	5426	6007	---	---
12	4205	4678	5438	6541	8066	9405	---
13	5189	5677	6452	7563	9079	10056	11438
14	4519	4958	5658	6667	8055	8955	10236
15	3718	0	0	---	---	---	---
16	4402	5020	5583	6592	8037	9636	10833
17	5189	5677	6452	7563	9079	10056	11436
18	9489	9489	11650	11650	13340	13340	---
19	5638	6192	6973	8237	9613	11102	---
20	4513	4895	5293	6168	7403	8794	10428
21	6558	7123	7673	8924	10696	12688	14971
22	6846	7293	7993	8728	10304	12025	---
23	6277	6665	7272	7908	9171	10537	12062
24	5968	6863	7821	8841	---	---	---
25	6363	7056	7785	8666	---	---	---
26	7382	8179	9344	10944	12805	---	---
27	8377	9758	11249	12713	---	---	---
28	6363	7056	7785	8666	---	---	---
29	7382	8179	9344	10944	12805	---	---
30	7126	8286	9429	10422	---	---	---
31	4725	5422	6041	7339	8980	---	---
32	4585	4973	5390	6157	7196	8409	9136
33	3940	4272	4629	5297	6211	7265	7777
34	3939	4450	5034	5657	6829	8068	---
35	4545	5159	5814	7125	---	---	---
36	4297	4962	5573	6792	---	---	---
37	5931	6782	7881	---	---	---	---
38	4460	5464	---	---	---	---	---
39	4333	5096	6274	---	---	---	---
40	5082	6176	7311	---	---	---	---
41	2964	3681	4372	---	---	---	---
42	4324	4654	5473	6494	---	---	---
43	5082	6176	7311	---	---	---	---
44	2964	3681	4372	---	---	---	---
45	4324	4654	5473	6494	---	---	---
46	5108	5852	6766	---	---	---	---
47	4473	4995	5547	6129	---	---	---
48	5240	6330	7528	---	---	---	---
49	4970	5603	6375	8076	---	---	---
50	5495	6245	7045	8914	---	---	---
51	3561	3831	4159	4807	5672	---	---
52	3593	3871	4210	4825	5716	6689	---
53	3690	---	---	---	---	---	---
54	3586	---	---	---	---	---	---
55	5212	---	---	---	---	---	---

TABLE B-6: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 80°F , ELEVATION 3000 FT MSL (CONTINUED)

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
56	4136	---	---	---	---	---	---
57	3985	---	---	---	---	---	---
58	4633	---	---	---	---	---	---
59	5234	---	---	---	---	---	---
60	3779	---	---	---	---	---	---
61	6550	---	---	---	---	---	---
62	8243	---	---	---	---	---	---
63	3635	4580	6181	---	---	---	---
64	2356	---	---	---	---	---	---
65	1632	---	---	---	---	---	---
66	5203	6633	7930	---	---	---	---
67	3556	---	---	---	---	---	---
68	3450	---	---	---	---	---	---
69	1670	---	---	---	---	---	---
70	4289	5663	7273	---	---	---	---
71	2049	2502	0	---	---	---	---
72	2415	3143	---	---	---	---	---
73	2807	---	---	---	---	---	---
74	851	---	---	---	---	---	---
75	995	---	---	---	---	---	---
76	2136	---	---	---	---	---	---
77	943	---	---	---	---	---	---
78	14702	---	---	---	---	---	---
79	5566	8681	---	---	---	---	---
80	6915	9469	---	---	---	---	---
81	6073	9074	---	---	---	---	---
82	6902	10313	---	---	---	---	---
83	5067	5638	6118	7142	8540	10559	12269
84	5511	5965	6417	7540	9049	10853	12519
85	4921	5721	6363	7758	---	---	---
86	4626	5344	6003	7320	---	---	---
87	3785	4103	4449	5096	5979	7002	7497
88	4062	0	0	---	---	---	---
89	4315	5299	6249	---	---	---	---
90	4380	5351	6427	---	---	---	---
91	15127	---	---	---	---	---	---
92	12506	---	---	---	---	---	---
93	4402	4880	5579	6540	7659	---	---
94	4153	4605	5081	5656	---	---	---
95	3999	---	---	---	---	---	---
96	5756	---	---	---	---	---	---
97	5134	6109	7276	8442	---	---	---
98	5536	---	---	---	---	---	---
99	3183	---	---	---	---	---	---
100	4513	5004	5522	6146	---	---	---
101	5460	6050	6913	8098	9476	---	---
102	5970	6451	6952	8200	9557	11245	13320
103	6372	6892	7433	8782	10254	12089	14351
104	3000	---	---	---	---	---	---
105	3000	---	---	---	---	---	---
106	3000	---	---	---	---	---	---
107	3000	---	---	---	---	---	---

TABLE B-7: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 59°F , ELEVATION 6000 FT MSL

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
1	4358	4732	5223	5842	7545	7788	---
2	7231	7823	8441	9925	11917	14319	16507
3	5819	6346	7039	7922	10380	10735	---
4	4096	4581	5072	5870	7043	8300	10467
5	5763	6227	6711	7870	9419	11279	12966
6	4193	4671	5438	6551	8098	9433	---
7	3963	4429	5176	6263	7767	8547	---
8	2721	3109	3523	4193	4671	---	---
9	4949	5642	6274	7406	9027	10818	12160
10	2799	3128	3656	4424	5486	6037	---
11	4142	4680	5252	6176	6837	---	---
12	4961	5520	6416	7717	9518	11098	---
13	6117	6692	7605	8915	10702	11854	13484
14	5128	5625	6418	7561	9132	10151	11600
15	0	0	0	---	---	---	---
16	4949	5642	6274	7406	9027	10818	12160
17	6117	6692	7605	8915	10702	11854	13484
18	10886	10886	13362	13362	15298	15298	---
19	6694	7351	8279	9780	11415	13185	---
20	5095	5525	5974	6961	8352	9918	11758
21	7753	8422	9072	10550	12646	15082	17702
22	7807	8316	9112	9948	11741	13698	---
23	7189	7634	8328	9054	10499	12061	13803
24	5968	6863	7821	8841	---	---	---
25	7483	8298	9156	10191	---	---	---
26	8729	9671	11049	12942	15142	---	---
27	9952	11592	13365	15105	---	---	---
28	7483	8298	9156	10191	---	---	---
29	8729	9671	11049	12942	15142	---	---
30	8423	9795	11146	12320	---	---	---
31	5605	6432	7167	8708	10655	---	---
32	5191	5629	6101	6967	8140	9510	10331
33	4347	4712	5105	5840	6845	8004	8566
34	4329	4889	5529	6211	7493	8848	---
35	4985	5656	6372	7804	---	---	---
36	4868	5620	6311	7689	---	---	---
37	7016	8023	9323	---	---	---	---
38	5089	6235	---	---	---	---	---
39	4966	5840	7188	---	---	---	---
40	5983	7270	8607	---	---	---	---
41	3481	4323	5135	---	---	---	---
42	5121	5512	6483	7692	---	---	---
43	5983	7270	8607	---	---	---	---
44	3481	4323	5135	---	---	---	---
45	5121	5512	6483	7692	---	---	---
46	6011	6887	7962	---	---	---	---
47	5288	5905	6557	7245	---	---	---
48	5939	7173	8529	---	---	---	---
49	5650	6368	7245	9176	---	---	---
50	6354	7220	8145	10305	---	---	---
51	4040	4346	4718	5451	6431	---	---
52	3970	4276	4649	5327	6308	7378	---
53	4103	---	---	---	---	---	---
54	4172	---	---	---	---	---	---
55	6104	---	---	---	---	---	---

TABLE B-7: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 59°F , ELEVATION 6000 FT MSL (CONTINUED)

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
56	4136	---	---	---	---	---	---
57	4399	---	---	---	---	---	---
58	5180	---	---	---	---	---	---
59	6192	---	---	---	---	---	---
60	4168	---	---	---	---	---	---
61	7322	---	---	---	---	---	---
62	6054	---	---	---	---	---	---
63	3960	4989	6733	---	---	---	---
64	2613	---	---	---	---	---	---
65	1778	---	---	---	---	---	---
66	5667	7225	8639	---	---	---	---
67	3874	---	---	---	---	---	---
68	3758	---	---	---	---	---	---
69	1820	---	---	---	---	---	---
70	4672	6169	7923	---	---	---	---
71	2232	2726	0	---	---	---	---
72	2631	3424	---	---	---	---	---
73	3057	---	---	---	---	---	---
74	928	---	---	---	---	---	---
75	1084	---	---	---	---	---	---
76	2327	---	---	---	---	---	---
77	1027	---	---	---	---	---	---
78	17276	---	---	---	---	---	---
79	6260	9762	---	---	---	---	---
80	7779	10648	---	---	---	---	---
81	6616	9885	---	---	---	---	---
82	7519	11234	---	---	---	---	---
83	5744	6391	6934	8092	9673	11956	13889
84	6267	6783	7296	8571	10283	12329	14218
85	5582	6488	7215	8794	---	---	---
86	5073	5858	6578	8016	---	---	---
87	4381	4749	5148	5897	6918	8101	8674
88	0	0	0	---	---	---	---
89	4739	5815	6854	---	---	---	---
90	5068	6190	7434	---	---	---	---
91	17102	---	---	---	---	---	---
92	14072	---	---	---	---	---	---
93	5034	5580	6378	7475	8753	---	---
94	4833	5359	5913	6582	---	---	---
95	4448	---	---	---	---	---	---
96	6659	---	---	---	---	---	---
97	6095	7253	8639	10023	---	---	---
98	6323	---	---	---	---	---	---
99	3528	---	---	---	---	---	---
100	4513	5004	5522	6146	---	---	---
101	5460	6050	6913	8098	9476	---	---
102	6256	6758	7281	8581	9994	11750	13906
103	6435	6955	7498	8848	10319	12149	14402
104	3000	---	---	---	---	---	---
105	3000	---	---	---	---	---	---
106	3000	---	---	---	---	---	---
107	3000	---	---	---	---	---	---

TABLE B-8: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 40°F , ELEVATION 6000 FT MSL

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
1	4358	4732	5223	5842	7545	7788	---
2	6652	7197	7766	9131	10964	13173	15186
3	5354	5838	6476	7288	9549	9876	---
4	3768	4215	4666	5400	6479	7636	9630
5	5302	5729	6174	7240	8665	10376	11928
6	4193	4671	5438	6551	8098	9433	---
7	3963	4429	5176	6263	7767	8547	---
8	2721	3109	3523	4193	4671	---	---
9	4553	5190	5772	6813	8304	9952	11187
10	2799	3128	3656	4424	5486	6037	---
11	3811	4305	4832	5682	6290	---	---
12	4564	5078	5902	7100	8756	10210	---
13	5627	6157	6997	8202	9846	10906	12405
14	4718	5175	5904	6956	8401	9338	10671
15	0	0	0	---	---	---	---
16	4553	5190	5772	6813	8304	9952	11187
17	5627	6157	6997	8202	9846	10906	12405
18	10014	10014	12293	12293	14074	14074	---
19	6158	6763	7616	8997	10501	12129	---
20	4687	5083	5496	6404	7684	9124	10817
21	7132	7748	8346	9706	11634	13801	16285
22	7182	7650	8383	9152	10801	12602	---
23	6614	7023	7661	8330	9659	11096	12698
24	5968	6863	7821	8841	---	---	---
25	6885	7634	8423	9176	---	---	---
26	8030	8898	10165	11906	13930	---	---
27	9155	10665	12295	13896	---	---	---
28	6885	7634	8423	9176	---	---	---
29	8030	8898	10165	11906	13930	---	---
30	7749	9011	10254	11334	---	---	---
31	5157	5917	6594	8011	9803	---	---
32	4775	5178	5613	6409	7489	8749	9504
33	3999	4335	4697	5373	6297	7364	7881
34	3982	4497	5086	5714	6894	8140	---
35	4586	5203	5862	7179	---	---	---
36	4472	5163	5798	7064	---	---	---
37	6455	7381	8577	---	---	---	---
38	4682	5736	---	---	---	---	---
39	4569	5373	6613	---	---	---	---
40	5504	6689	7918	---	---	---	---
41	3202	3977	4724	---	---	---	---
42	4712	5071	5964	7077	---	---	---
43	5504	6689	7918	---	---	---	---
44	3202	3977	4724	---	---	---	---
45	4712	5071	5964	7077	---	---	---
46	5530	6336	7325	---	---	---	---
47	4864	5432	6032	6665	---	---	---
48	5464	6599	7846	---	---	---	---
49	5198	5859	6665	8442	---	---	---
50	5845	6643	7493	9480	---	---	---
51	3717	3998	4340	5015	5917	---	---
52	3651	3933	4276	4900	5802	6786	---
53	3775	---	---	---	---	---	---
54	3838	---	---	---	---	---	---
55	5616	---	---	---	---	---	---

TABLE B-8: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 40°F , ELEVATION 6000 FT MSL (CONTINUED)

IRN #	STAGE WEIGHT						
	1	2	3	4	5	6	7
56	4136	---	---	---	---	---	---
57	4047	---	---	---	---	---	---
58	4766	---	---	---	---	---	---
59	5697	---	---	---	---	---	---
60	3834	---	---	---	---	---	---
61	6736	---	---	---	---	---	---
62	5569	---	---	---	---	---	---
63	3576	4505	6080	---	---	---	---
64	2404	---	---	---	---	---	---
65	1606	---	---	---	---	---	---
66	5117	6524	7800	---	---	---	---
67	3498	---	---	---	---	---	---
68	3394	---	---	---	---	---	---
69	1643	---	---	---	---	---	---
70	4218	5571	7154	---	---	---	---
71	2015	2461	0	---	---	---	---
72	2376	3092	---	---	---	---	---
73	2761	---	---	---	---	---	---
74	838	---	---	---	---	---	---
75	979	---	---	---	---	---	---
76	2101	---	---	---	---	---	---
77	927	---	---	---	---	---	---
78	15893	---	---	---	---	---	---
79	5759	8981	---	---	---	---	---
80	7156	9796	---	---	---	---	---
81	5974	8926	---	---	---	---	---
82	6789	10144	---	---	---	---	---
83	5285	5879	6379	7444	8899	10999	12777
84	5766	6240	6712	7885	9460	11342	13080
85	5135	5969	6638	8090	---	---	---
86	4667	5389	6052	7374	---	---	---
87	4030	4369	4736	5425	6364	7453	7980
88	0	0	0	---	---	---	---
89	4360	5349	6305	---	---	---	---
90	4662	5695	6840	---	---	---	---
91	15711	---	---	---	---	---	---
92	12946	---	---	---	---	---	---
93	4631	5133	5868	6877	8052	---	---
94	4446	4930	5440	6055	---	---	---
95	4092	---	---	---	---	---	---
96	6126	---	---	---	---	---	---
97	5607	6673	7948	9221	---	---	---
98	5817	---	---	---	---	---	---
99	3245	---	---	---	---	---	---
100	4513	5004	5522	6146	---	---	---
101	5460	6050	6913	8098	9476	---	---
102	5327	5754	6198	7301	8499	9988	11815
103	5395	5830	6283	7410	8636	10160	12035
104	3000	---	---	---	---	---	---
105	3000	---	---	---	---	---	---
106	3000	---	---	---	---	---	---
107	3000	---	---	---	---	---	---

TABLE B-9: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 80°F , ELEVATION 6000 FT MSL

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
1	4358	4732	5223	5842	7545	7788	---
2	7902	8549	9224	10846	13023	15647	18038
3	6359	6935	7692	8657	11342	11730	---
4	4476	5006	5542	6415	7696	9070	11438
5	6297	6805	7334	8600	10293	12325	14168
6	4193	4671	5438	6551	8098	9433	---
7	3963	4429	5176	6263	7767	8547	---
8	2721	3109	3523	4193	4671	---	---
9	5408	6165	6856	8093	9864	11822	13288
10	2799	3128	3656	4424	5486	6037	---
11	4526	5114	5739	6749	7471	---	---
12	5421	6032	7011	8433	10401	12127	---
13	6684	7313	8311	9742	11695	12954	14735
14	5604	6147	7013	8262	9979	11092	12676
15	0	0	0	---	---	---	---
16	5408	6165	6856	8093	9864	11822	13288
17	6684	7313	8311	9742	11695	12954	14735
18	11895	11895	14601	14601	0	0	---
19	7315	8033	9047	10687	12474	14408	---
20	5567	6038	6529	7607	9127	10838	12849
21	8472	9203	9913	11529	13819	16393	19344
22	8531	9087	9957	10871	12830	14969	---
23	7856	8342	9100	9894	11473	13179	15083
24	5968	6863	7821	8841	---	---	---
25	8178	9068	10005	11137	---	---	---
26	9539	10569	12074	14142	16567	---	---
27	10875	12668	14604	16506	---	---	---
28	8178	9068	10005	11137	---	---	---
29	9539	10569	12074	14142	16547	---	---
30	9204	10703	12180	13463	---	---	---
31	6125	7029	7832	9516	11644	---	---
32	5672	6151	6667	7613	8895	10392	11289
33	4750	5149	5579	6382	7480	8747	9361
34	4730	5342	6042	6787	8188	9669	---
35	5447	6280	6963	8528	---	---	---
36	5227	6151	6907	8415	---	---	---
37	7667	8767	10188	---	---	---	---
38	5562	6813	---	---	---	---	---
39	5427	6382	7855	---	---	---	---
40	6538	7945	9405	---	---	---	---
41	3804	4724	5611	---	---	---	---
42	5596	6024	7084	8406	---	---	---
43	6538	7945	9405	---	---	---	---
44	3804	4724	5611	---	---	---	---
45	5596	6024	7084	8406	---	---	---
46	6569	7526	8701	---	---	---	---
47	5778	6452	7165	7917	---	---	---
48	6490	7838	9320	---	---	---	---
49	6174	6959	7917	10027	---	---	---
50	6943	7890	8901	11261	---	---	---
51	4415	4749	5156	5957	7028	---	---
52	4339	4674	5082	5823	6895	8065	---
53	4484	---	---	---	---	---	---
54	4559	---	---	---	---	---	---
55	6670	---	---	---	---	---	---

TABLE B-9: RUNWAY REQUIREMENTS/OPERATIONAL BOUNDARIES OF THE PROFILE GENERATOR, TEMPERATURE 80°F , ELEVATION 6000 FT MSL (CONTINUED)

INM #	STAGE WEIGHT						
	1	2	3	4	5	6	7
56	4136	---	---	---	---	---	---
57	4807	---	---	---	---	---	---
58	5661	---	---	---	---	---	---
59	6766	---	---	---	---	---	---
60	4555	---	---	---	---	---	---
61	8001	---	---	---	---	---	---
62	6615	---	---	---	---	---	---
63	4414	5561	7505	---	---	---	---
64	2855	---	---	---	---	---	---
65	1982	---	---	---	---	---	---
66	6317	8054	9629	---	---	---	---
67	4328	---	---	---	---	---	---
68	4189	---	---	---	---	---	---
69	2028	---	---	---	---	---	---
70	5207	6876	8831	---	---	---	---
71	2487	3038	0	---	---	---	---
72	2933	3817	---	---	---	---	---
73	3408	---	---	---	---	---	---
74	1034	---	---	---	---	---	---
75	1208	---	---	---	---	---	---
76	2593	---	---	---	---	---	---
77	1145	---	---	---	---	---	---
78	18878	---	---	---	---	---	---
79	6840	10668	---	---	---	---	---
80	8500	11636	---	---	---	---	---
81	7374	12018	---	---	---	---	---
82	8381	0	---	---	---	---	---
83	6277	6983	7577	8842	10570	13065	15177
84	6848	7412	7973	9366	11237	13473	15537
85	6100	7090	7884	9609	---	---	---
86	5544	6401	7188	8759	---	---	---
87	4787	5190	5626	6444	7559	8853	9478
88	0	0	0	---	---	---	---
89	5178	6354	7489	---	---	---	---
90	5538	6764	8124	---	---	---	---
91	18717	---	---	---	---	---	---
92	15377	---	---	---	---	---	---
93	5501	6097	6970	8169	9565	---	---
94	5281	5856	6462	7193	---	---	---
95	4860	---	---	---	---	---	---
96	7277	---	---	---	---	---	---
97	6660	7926	9440	10953	---	---	---
98	6909	---	---	---	---	---	---
99	3855	---	---	---	---	---	---
100	4513	5004	5522	6146	---	---	---
101	5460	6050	6913	8098	9476	---	---
102	7503	8107	8737	10302	12006	14124	16729
103	7878	8519	9187	10851	12665	14926	17713
104	3000	---	---	---	---	---	---
105	3000	---	---	---	---	---	---
106	3000	---	---	---	---	---	---
107	3000	---	---	---	---	---	---

APPENDIX C

AIRPLANE RUNUP OPERATIONS

This Appendix discusses the adaptation of an existing INM equation for use in computing runup noise within INM Version 4.11. This equation, also used in the Time-Above-Threshold (TA) equation, can be used to approximate the maximum A-weighted sound level (L_{AMAX}) and the maximum tone-corrected perceived noise level ($PNLT_{MAX}$) for a one-second time period as follows:

$$L_{AMAX} = SEL - 10\log_{10}[((500\pi)/(V))(.001R_0)^{(k)}] \text{ and} \quad (1)$$

$$PNLT_{MAX} = EPNL - 10\log_{10}[((500\pi)/(V))(.001R_0)^{(k)}] + 10, \quad (2)$$

where

- SEL = the Sound Exposure Level from the Noise-Power-Distance data base (dBA);
- EPNL = the Effective Perceived Noise Level from the Noise-Power-Distance data base (dB);
- V = the airplane velocity (ft/sec);
- R_0 = the closest point of approach from airplane to receiver (ft);
- k = a constant exponent with a fixed value of 0.6 in the INM; and for Equation (2),
- 10 = a duration correction as discussed in Section 2.3, Equation (2).

The above equations assume: (1) an approximate shape of an airplane's sound level time history; and (2) symmetry in the time history trace around the L_{AMAX} or $PNLT_{MAX}$, as appropriate. The $L_{AMAX}/PNLT_{MAX}$ values computed with these equations were verified using measured $L_{AMAX}/PNLT_{MAX}$ data in the literature.[1]

Given the computed $L_{AMAX}/PNLT_{MAX}$ and the user-defined duration and location for a runup, the SEL/EPNL for the runup is computed by multiplying the acoustic energy associated with the $L_{AMAX}/PNLT_{MAX}$ by the user-defined duration, and converting the total runup energy to a decibel value as follows:

$$SEL_{RUNUP} = 10\log_{10}[(DUR)10\exp(L_{AMAX}/10)] \text{ and} \quad (3)$$

$$EPNL_{RUNUP} = 10\log_{10}[(DUR)10exp(PNLT_{MAX}/10)], \quad (4)$$

where	SEL_{RUNUP}	=	the Sound Exposure Level for the runup (dBA);
	$EPNL_{RUNUP}$	=	the Effective Perceived Noise Level for the runup (dB);
	DUR	=	the user-defined duration of the runup (seconds);
	L_{AMAX}	=	the maximum A-weighted sound level computed, using Equation (1);
and	$PNLT_{MAX}$	=	the maximum tone-corrected perceived noise level computed, using Equation (2).

The SEL_{RUNUP} value from Equation (3) is then used to compute the noise exposure due to runup operations for all INM noise metrics, except NEF and WECPNL. The noise exposure due to runup operations for NEF and WECPNL are computed using the $EPNL_{RUNUP}$ value from Equation (4).

C.1 Verification

The runup enhancement within INM Version 4.11 was verified using measured runup noise level data for the A320 airplane with the newer CFM56-5-A1 engine, and the B747 airplane with the older JT9D-7A engine.[2,3] The measured data for the A320 agree extremely well with INM-predicted data, i.e., ± 3 dB with a mean difference of .6 dB and a standard deviation of 2.2 dB, for receivers located at angles of 0, 45, 90, 120, 135, and 180 degrees relative to the nose of the airplane. Note: At 180 degrees, the data used for comparison with the predicted levels were obtained by linear extrapolation of measured data. The agreement between measured and predicted data at the above six receiver locations was essentially independent of thrust for thrusts of 78, 86, and 90 percent N1. At the 150 degree location, the agreement was only modest. INM Version 4.11 overstated the noise by approximately 6 dB at thrust levels of 86 and 90 percent N1, and by almost 12 dB at 78 percent N1. Similar results were observed for the B747 airplane at all receiver locations.

The agreement between measured and predicted runup noise levels could be improved if the INM maintained a detailed data base of measured runup directivity patterns for all airplanes as a function of distance and thrust. In lieu of developing such a substantial and potentially costly data base, the simplified directivity pattern discussed in Appendix A is a reasonable approximation of runup directivity.

C.2 References

1 Bishop, D.E., Beckman, J.M., Bucka, M.P., Revision of Civil Aircraft Noise Data for the Integrated Noise Model (INM), Report No. 6039, Project No. 04453, Canoga Park, CA: BBN Laboratories Incorporated, September 1986.

2 A320 Noise Definition Manual NDM, FRANCE: Airbus Industrie, 1990.

3 An Excerpt from the Model B747 Flight Manual, A-Weighted Noise Level Contours, Seattle, WA: Boeing Commercial Airplane Company, 1986.

APPENDIX D

INM INPUT TESTCASE

This Appendix presents a copy of the INM Input Testcase, revised to reflect several INM Version 4.11 enhancements. The revised Testcase includes an airplane runup definition, and an approach runway threshold definition. The entry related to data base selection, contained in the PROCESS section of previous versions of the Input Testcase, has been deleted; the ACDB11.EXE computer program, included with the INM Version 4.11 release, should be used to access/print all elements of Data Base Number 11. The Input Testcase contained herein is included with the Version 4.11 release.

```
BEGIN.

SETUP:

  TITLE <ANNUAL AVERAGE EXPOSURE AT AN EXAMPLE OF A MEDIUM HUB AIRPORT>
  AIRPORT <EXAMPLE MHA>

  ALTITUDE 0
  TEMPERATURE 59 F

  RUNWAYS
    RW 09L-27R      0       0          TO  9487    -497    HEADING=93
    RW 27L-09R   4203   -1410          TO -6920   -1044    HEADING=272
    RW  35-17    7355    1366 DT 100   TO  6407    6742

AIRCRAFT:

  TYPES
    AC 747200
    AC DC1030
    AC DC870
    AC A300
    AC 757PW
    AC 727Q15
    AC DC930
    AC MD81
    AC 737300
    AC SABR80
    AC BEC58P
    AC S-76     CURVE=250C30 PARAM=HELI STAGE 1=HORFLT
                CATEGORY=PGA

NOISE CURVES

  NC 250C30           3 BY 8   3 BY 8
  EPNL
  THRUSTS      1         2        3
      200   90.2      91.2     97.2
      400   85.8      87.2     93.1
      600   83.1      84.5     90.6
     1000   79.4      80.7     87.4
     2000   73.7      75.1     82.6
     4000   67.6      68.2     77.2
     6000   63.1      63.8     73.7
    10000   56.8      57.4     68.7
  SEL
  THRUSTS      1         2        3
      200   88.6      90.0     95.6
      400   84.2      85.6     91.5
      600   81.5      82.9     89.0
     1000   77.8      79.1     85.8
     2000   72.1      73.5     81.0
     4000   66.0      66.6     75.6
     6000   61.5      62.2     72.1
    10000   55.2      55.8     67.1

APPROACH PARAMETERS

  AP HELI   WEIGHT=10000 ENGINE=2 STOP=1
            FINSP=160 TAXI=160
            LNDFFS=3

INT.NM.

PROFILES APPROACH

  PF ALT3D SEGMENTS=7
     DISTANCES     20.     10.     5.      3.     1.  -.164  STOP
     ALTITUDES    6000    3236    1644    1007    370     0     0
     SPEEDS      TERMSP  INTSP  APPSP   FINSP  LNDSP REVSP  TAXI
     THRUSTS     INTFIS APPFAS LNDFFS  LNDFLS   REV   IDLE

  PF COPTR SEGMENTS=7
     DISTANCES      3.9     3.1     2.4     1.6     0.8      0     0
     ALTITUDES     2500    2000    1500    1000     500      0     0
     SPEEDS       FINSP   FINSP   FINSP   FINSP   FINSP  FINSP  TAXI
     THRUSTS     LNDFFS  LNDFFS  LNDFFS  LNDFFS  LNDFFS LNDFFS

ECHO.

FT.

  PROFILES TAKEOFF

    PF HORFLT SEGMENTS=8 WEIGHT=10000 ENGINES=2
      DISTANCES      0    1376    4126    6876    6877    9626   10000   15000
      ALTITUDES      0       0     500    1000    1000    1500    1500    1500
      SPEEDS        32     160     160     160     160     160     160     160
      THRUSTS        2       2       2       2       1       1       1
```

COMMENTS:

Note: Standard conditions have been defined. To implement the takeoff profile generator see Section 2.1. In addition, the elevation enhancement has not been selected. To implement elevation see Section 2.2.

Note: A runway touch-down point of 1054 ft has been defined for approach operations on Runway 35 (i.e., 100 ft for the user-defined DT plus 954 ft for the fixed touch-down point).

INT.NM.

TAKEOFFS BY FREQUENCY:

```
  TRACK TR1 RWY 09L STRAIGHT 4.1 LEFT 5 H 1.6 STRAIGHT 50
    OPER 747200 RUNUP 1 D=10 STAGE 1 D=1.1 STAGE 2 D=1.1 STAGE 3 D=1.1
    OPER DC1030 STAGE 1 D=1.5 STAGE 2 D=2.5 STAGE 4 D=2
    OPER 757PW  STAGE 2 D=1.5
    OPER 727Q15 STAGE 1 D=3 N=.5 STAGE 2 D=2.6 N=.6
                STAGE 3 D=1.2 N=.1
    OPER DC930  STAGE 1 D=26.5 N=.5 STAGE 2 D=8 N=.5
                STAGE 3 D=1.5
    OPER MD81   STAGE 2 D=1.0
    OPER 737300 STAGE 1 D=1.5 N=.5

  TRACK TR2 RWY 27R STRAIGHT 4.1 LEFT 88 D 1.6 STRAIGHT 50
    OPER DC1030 STAGE 1 D=1.5 STAGE 2 D=3 STAGE 3 D=1
                STAGE 4 D=1 STAGE 5 D=.5 STAGE 6 D=.5
    OPER DC870  STAGE 1 D=2 N=.5 STAGE 2 D=3.5 N=1
                STAGE 3 D=1 STAGE 4 D=2.5 STAGE 5 D=1
                STAGE 6 D=.5
    OPER A300   STAGE 2 D=2 STAGE 3 D=1
    OPER 727Q15 STAGE 1 D=6 N=1 STAGE 2 D=4.4 N=1.4 STAGE 3 D=1.8
                        N=.4

  TRACK TR3 RWY 09R STRAIGHT 1.3 LEFT 15 D 1.0 STRAIGHT 1.4
                    RIGHT 57 D 1.8 STRAIGHT .5 RIGHT 50 D 1.6
                    STRAIGHT 50
    OPER DC870  STAGE 1 D=2 N=.5 STAGE 2 D=3.5 N=1 STAGE 3 D=1
                STAGE 4 D=1.5 STAGE 5 D=.5
    OPER 757PW  STAGE 3 D=2.5
    OPER 727Q15 STAGE 1 D=21 N=2.5 STAGE 2 D=16.5 N=4
                STAGE 3 D=8 N=.5
    OPER DC930  STAGE 1 D=26.5 N=.5 STAGE 2 D=8 N=.5 STAGE 3 D=1.5
    OPER MD81   STAGE 1 D= 3 N=.5
    OPER 737300 STAGE 2 D=.5

  TRACK TR4 RWY 27R STRAIGHT 4.1 LEFT 230 H 2.2 STRAIGHT 50
    OPER SABR80 STAGE 1 D=3 N=.1

  TRACK TR5 RWY 35 STRAIGHT 50
    OPER SABR80 STAGE 1 D=30.5 N=2.5
    OPER BEC58P STAGE 1 D=13 N=1

  TRACK TR6 RWY 17 STRAIGHT 50
    OPER SABR80 STAGE 1 D=12.5 N=.5
    OPER BEC58P STAGE 1 D=30 N=3

  TRACK TR7 RWY 17 STRAIGHT 1.5 RIGHT 265 H .25 STRAIGHT 3
                   LEFT 245 H 1.0 STRAIGHT 50
    OPER S-76   STAGE 1 D=5
```

LANDINGS BY PERCENTAGE:

```
    OPER 747200 PROF=STD3D D=3 N=0
    OPER DC1030 PROF=STD3D D=22 N=2
    OPER DC870  PROF=ALT3D D=22 N=2
    OPER A300   PROF=STD3D D=2 N=1
    OPER 757PW  PROF=STD3D D=6 N=1
    OPER 727Q15 PROF=ALT3D D=70 N=10
    OPER DC930  PROF=ALT3D D=70 N=4
    OPER MD81   PROF=STD3D D=4 N=.5
    OPER 737300 PROF=STD3D D=1.5 N=.5
    OPER SABR80 PROF=STD3D D=25 N=2
    OPER BEC58P PROF=STD5D D=42 N=5
    OPER S-76   PROF=COPTR D=5

  TRACK TR8 RWY 27R STRAIGHT 50 RIGHT 82 D 1.5 STRAIGHT 4.2
                    PERCENT COM=72 GA=0

  TRACK TR9 RWY 09R HEADING 260 STRAIGHT 50 RIGHT 272 H 1.5
                    STRAIGHT 7 PERCENT COM=28 GA=0

  TRACK TR10 RWY 35 STRAIGHT 50 PERCENT COM=0 GA=30

  TRACK TR11 RWY 17 STRAIGHT 50 PERCENT COM=0 GA=70
```

TOUCHNGOS BY FREQUENCY:

```
  TRACK TR14 RWY 17 STRAIGHT 3 LEFT 180 D 2.0 STRAIGHT 6
                    LEFT 180 D 2.0 STRAIGHT 3
    OPER BEC58P STAGE 1 PROF STD5D D=23
```

COMMENTS:

Note: A runup operation has been defined for the B747-200 airplane. The runup takes place at the start of Runway 09L and lasts for 10 seconds, (i.e., in terms of average yearly duration).

```
PROCESSES:

PT.

NOMARM.

  GRID MEF LDN TA START=-3000 1500 STEP=1000 700 SIZE=2 BY 3

  GRID LEQ TA DBA=75 START=11000 3000 STEP=0 0 SIZE=1 BY 1 DETAIL

  CONTOUR LDN AT 65 75
          PLOT SIZE=11 8.5 SCALE=8000

END.
```

APPENDIX E

WINM USER'S MANUAL

This Appendix contains a copy of the User's Manual for the WINM computer software, an INM Version 4.11 plotting program for use with Microsoft Windows. The WINM software and its User's Manual, contained herein, were prepared by the SysTeam Corporation under contract to the FAA.

WINM

Windows Plotting Program
Supplement to Integrated Noise Model Version 4.11

User's Manual

November 17, 1993

Prepared by:

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SysTeam Corporation
Gaithersburg, MD

Prepared for:

Federal Aviation Administration
Washington, DC

FAA Contract # DTFA01-92-Y-01042
Task Order #1

1.0 INTRODUCTION

This User Guide is a combined tutorial-manual that comes to you as part of WINM 4.11.

2.0 OPERATIONAL REQUIREMENTS

Software/Hardware Requirements

WINM has the same software and hardware requirements as Microsoft Windows 3.x.

3.0 INSTALLATION

Before you start, make sure that you have all the material supplied with WINM 4.11 and check that your equipment matches the list in Chapter 2.

Installation Procedure

WINM comes with four files under the directory \INM411. These files will be installed as part of the primary INM installation. They are:

WINM.EXE	- The window plot program for INM
INMINPUT.TST	- Test case version of input data
CONTOURS.TST	- Test case version of contour data
INMCOLOR.DATA	- Color control file

Windows Installation of WINM

- Start up Windows by typing WIN.
- Open Windows' ***Program Manager***.
- Open the Windows ***File*** menu. Select ***New***.
- The ***New Program Object*** dialog box will appear.
- Select ***Program Group*** and click on ***OK***.
- The ***Program Group Properties*** dialog box will appear.
- Type WINM in the ***Description*** field. Click on ***OK***.
- Open the Windows ***File*** menu. Select ***New***.
- The ***New Program Object*** dialog box will appear.
- Select ***Program Item*** and click on ***OK***.

- The ***Program Item Properties*** dialog box will appear. Enter the text in the fields as indicated:

  For Window 3.1 environment:

  Description: WINM v4.11
  Command line: C:\INM411\WINM
  Working Directory: C:\INM411
  Shortcut Key: None

  For Windows 3.0 environment:

  Description: WINM 4. 11
  Command line: C:\INM411\WINM
  Shortcut Key: None

- Click on **OK**.
- Run WINM by double clicking the WINM icon.

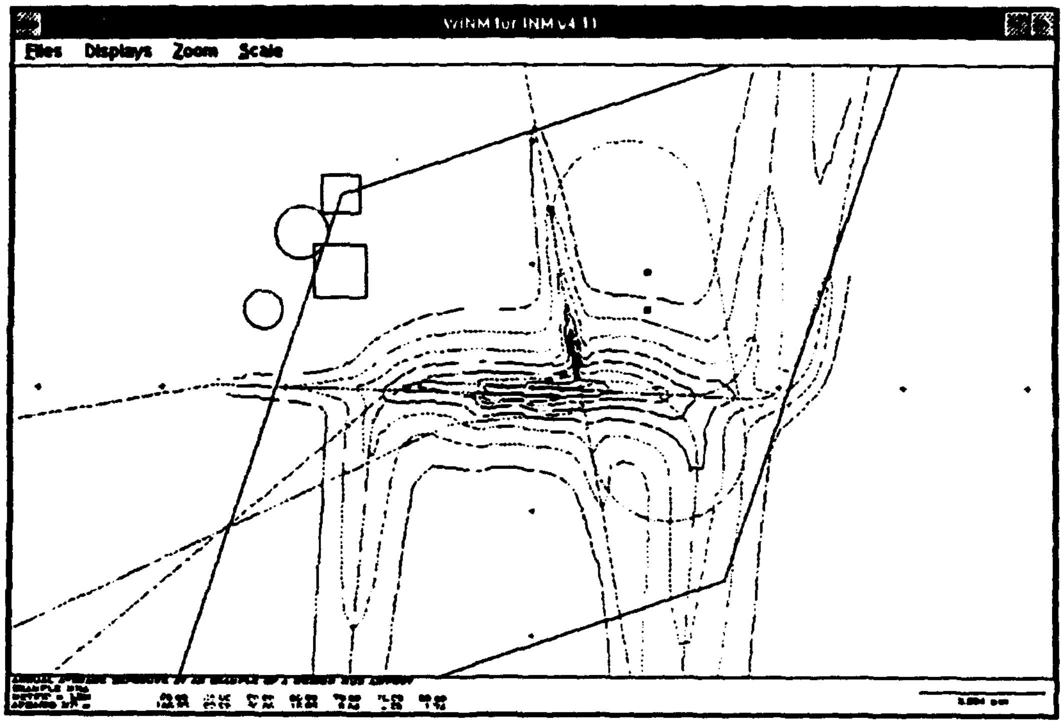
4.0 TUTORIAL

About the Tutorial

The tutorial has been structured so that the exercises will give you progressive familiarity with the operations that you will carry out within WINM 4.11.

4.1 Loading INM Files

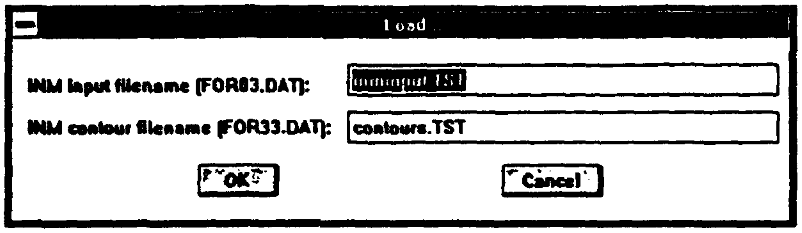
The starting point for this exercise is the default screen you see as soon as you start WINM 4.11 from the Windows *Program Manager*.



By default, WINM uses two default INM input files. To load a different set of input files,

- Place the mouse pointer arrow on ***Files*** in the menu bar; and
- Click once on the left mouse button.
- In the menu, click the mouse pointer on ***Load***.

See the ***Load*** dialog box.



About the Load Dialog Box

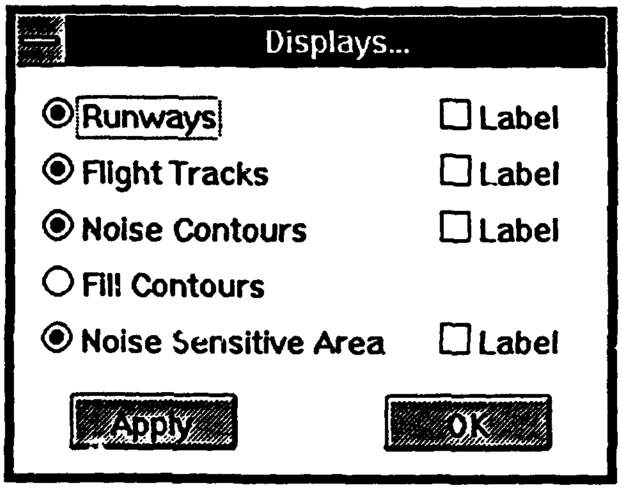
This menu option loads the INM input file and INM contour file. By default, test files "inminput.TST" "contours.TST" are chosen. Examples of standard input files are in the square brackets.

For this exercise, the default selections will not be changed. If you desire to select another set of INM input files in the future, use the ***Tab*** key to highlight the appropriate text field, then press the ***Backspace*** key to delete the default entry. Type in the appropriate file name. When correct, click on *OK*. For now, click on ***Cancel*** to close this window and continue with the tutorial.

4.2 Adjusting the Data Display Information

In the menu, click the mouse pointer on ***Displays***.

See the ***Displays*** dialog box.



About the Displays Dialog Box

This menu option allows the user to select which data display information is to be shown. Select any option one at a time and click on ***Apply*** to see its effect immediately. Experiment with as many combinations as you like. Text labels may be independently selected for each displayed item type by clicking on the ***Label*** box next to each item.

4.2.1 Runways

This radio button turns on/off the display of the runways.

4.2.2 Flight Tracks

This radio button turns on/off the display of the flight tracks.

4.2.3 Noise Contours

This radio button turns on/off the display of the noise contours.

4.2.4 Fill Contours

This radio button turns on/off the option to fill the contours.

4.2.5 Noise Sensitive Area

Although every one of these options depends on the INM input files selected, the ***Noise Sensitive Area*** is a special option. This menu option displays user-defined sensitive noise areas. These areas are defined after the END statement of the INM input data file (FOR03.DAT), and each can be either a polygon, square, circle, or point. The area can be defined in NM or FEET and a descriptive text label for label description of the area can be inserted after an asterisk (*) at the end of the line. The user can input/modify these data before or after running the noise model (but not during running the WINM program). The following shows an example of the descriptive text labels as seen in the default INM input filename '**inminput.TST**':

NOISE-AREA

P NM -10.0 -10.0 -5.0. 5.0 10.0 10.0 5.0 -5.0 * Poly Area
C NM -7.0 2.0 0.5 * Circle 1
C NM -6.0 4.0 0.7 * Circle 2
R NM -5.0 5.0 0.5 0.5 * Rect 1
R NM -5.0 3.0 0.7 0.7 * Rect 2
M NM 3.0 3.0 * Point 1
M NM 3.0 2.0 * Point 2
M FT 3000.0 1000.0 * Point 3
M FT 5000.0 2000.0 * Point 4

The formats for these areas are defined as follows:

NOISE-AREA

P <NM> <X1> <Y1> <X2> <Y2> ... <Xn> <Yn> * <Polygon Label>
Polygon area defined in NM followed by a series of X, Y points in NM with a label of 'Polygon Label'.

C <FT> <Xc> <Yc> <Radius> * <Circle Label>
Circle area defined in FT with its center at Xc, Yc, and its Radius with a label of 'Circle Label'.

R <FT> <Xc> <Yc> <Width> <Height> * <Rectangular Label>
Rectangle area defined in FT with its center at Xc, Yc, and its Width and Height from the center with a label of 'Rectangular Label'.

M <NM> <X> <Y> * <Point Label>
Mark point defined in NM at X, Y with a label of 'Point Label'.

Click on *OK* to leave the ***Displays*** dialog box.

4.3 Zoom

About the Zoom Menu

WINM 4.11 offers you the capabilities to zoom in/out of various sections of the display for specialize viewing.

We will now become familiarized with the zooming capabilities within WINM 4.11.

- Place the mouse pointer arrow on ***Zoom*** in the menu bar; and
- Click once on the left mouse button.

You will see the drop-down ***Zoom*** menu appear.

- In the menu, click the mouse pointer on ***Zoom In***.

A zoom box will appear in the center of the screen.

- Move the mouse to expand/shrink the zoom box.
- If you desire to move the zoom area, hold down the right button and drag the zoom box to a different area.
- Click the left button to accept zoom.

Note! At any time, click the right button to cancel the zoom box.

Zoom Out works similar to ***Zoom In***.

- Place the mouse pointer arrow on ***Zoom*** in the menu bar; and
- Click once on the left mouse button.

You will see the drop-down ***Zoom*** menu appear.

- In the menu, click the mouse pointer on ***Zoom Out***.

A zoom box will appear.

- Move the mouse to expand/shrink the zoom box.
- If you desire to move the zoom area, hold down the right button and drag the zoom box to a different area.

- Click the left button to accept zoom.

Note! At any time, click the right button to cancel the zoom box.

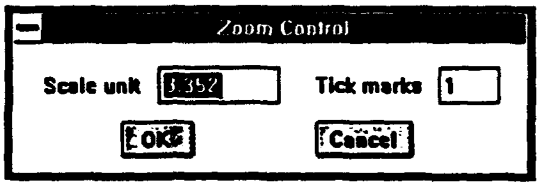
Zoom Control allows you more precise zoom control.

- Place the mouse pointer arrow on the ***Zoom*** menu; and
- Click once on the left mouse button.

You will see the drop-down ***Zoom*** menu appear.

- In the menu, click the mouse pointer on ***Zoom Control***.

See the ***Zoom Control*** dialog box.



This menu option allows you to set the scale value to a specific scale (i.e. 3.352 nm per scale unit) and to set the number of tic marks between the scale unit marks (default is 1). You can change these values anytime.

For now, let's continue with the exercise. Click on ***Cancel*** to leave the ***Zoom Control*** dialog box.

4.4 Scale

About the Scale Menu

WINM 4.11 offers you the capabilities to change the scale on which the display units.

We will now become familiarized with the scaling capabilities within WINM 4.11.

- Place the mouse pointer arrow on ***Scale*** in the menu bar; and
- Click once on the left mouse button.

You will see the drop-down *Scale* menu appear.

- In the menu, click the mouse pointer on any of the menu selections to see its effect to the scale shown at the bottom right-hand corner.

We have now covered the major capabilities of WINM 4.11.

Let's print the display to a printer.

- Place the mouse pointer arrow on ***Files*** in the menu bar; and
- Click once on the left mouse button.

You will see the drop-down ***Files*** menu appear.

- In the menu, click the mouse pointer on ***Print***. A submenu will appear.

4.5 Print

About the Print Menu Option

This menu option allows a hard copy output to a printer. The printout will go to the default printer which can be set via **Printers in Control Panel**.

- **Actual Scale**

  This menu option allows the user to print the current screen for scaling. The scale unit will reflect 1 inch on the hardcopy printout.

- **Screen Zoom**

  This menu option allows the user to print the current screen at the current zoom factor. The left and right edges of the hardcopy printout will be set to match the left and right edges of the screen display. If the printer's page orientation is set to 'Landscape' in the Windows ***Print Manager***, then the top and bottom edges of the hardcopy printout will be set to match the top and bottom edges of the screen display as well.

To print what is displayed, select ***Screen Zoom***.

You can now exit the program.

- Place the mouse pointer arrow on ***Files*** in the menu bar; and
- Click once on the left mouse button.

You will see the drop-down ***Files*** menu appear.

- In the menu, click the mouse pointer on *Exit*.

This menu option exits the program. The current display setup (contours on/off, tracks on/off, etc.) will be saved when the program is restarted, this setup will be recalled.

CONGRATULATIONS!! You have completed the tutorial.

5.0 Others

Move Origin

The user can move the origin by clicking on a point using the mouse's right button, holding it down, and dragging it to a new location.

Colors for Display

The user can modify the colors displayed on screen by modifying the appropriate fields in the file INMCOLOR.DAT. For every increment of 16 colors (up to 256), a new fill pattern will be automatically introduced. The user can modify the color file until the desired colors/patterns are found. Note that the ordering of these colors as they appear in the file is very crucial. An example is as follows:

```
4      /* Runway_Clr */
2      /* Landing_Track_Clr */
3      /* Takeoff_Track_Clr */
6      /* Touchngo_Track_Clr */
255    /* Level_40_Less_Clr */
237    /* Level_41_To_45_Clr */
173    /* Level_46_To_50_Clr */
27     /* Level_51_To_55_Clr */
102    /* Level_56_To_60_Clr */
85     /* Level_61_To_65_Clr */
68     /* Level_66_To_70_Clr */
50     /* Level_71_To_75_Clr */
140    /* Level_76_To_80_Clr */
17     /* Level_81_Greater_Clr */
```

Help

Help is not available directly from the program. For technical problems, please contact your distributor.

6.0 Program Limitation.

- Maximum 2000 points per noise contour.
- Runways information input is in FEET (from INM input file).
- Tracks information input is in NM (from INM input file).
- Shade pattern on hard copy may not be the same as on the screen due to the incompatibility number of colors support by the display and the printer.